(19)日本国特許庁（ＪＰ）　(12) 公開特許公報（A）　(11)特許出願公開番号

特開平9－45608

(43)公開日　平成9年(1997)2月14日

(51)Int.Cl.^{6}	識別記号	庁内整理番号	FI		技術表示箇所
H01L　21/027			H01L　21/30	518	
G03F　7/20	521		G03F　7/20	521	
9/00			9/00	H	
			H01L　21/30	516A	

審査請求　未請求　請求項の数7　OL　（全 13 頁）

(21)出願番号　特願平7－198648

(22)出願日　平成7年(1995)8月3日

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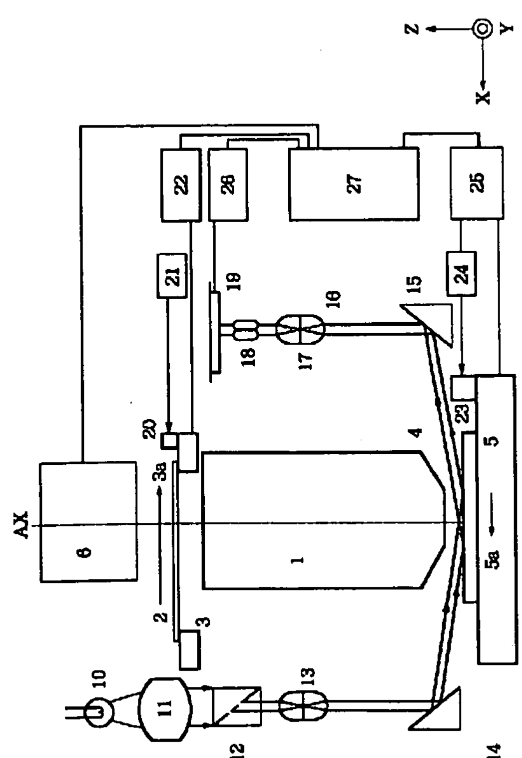
(54)【発明の名称】　面位置検出方法

(57)【要約】

【課題】　パターン構造に依存する誤差を補正してウエハー表面の位置を高精度に検出する事ができる面位置検出方法を提供する。

【解決手段】　面位置検出手段が面位置を検出する際の複数の検出ポイント間のパターン構造の違いにより生じる各検出ポイント毎の誤差を検出する段階と、前記物体を前記面位置検出手段に対して相対走査して、前記面位置検出手段で前記領域内の前記複数の検出ポイントの面位置を検出する際、検出ポイント毎に該検出ポイントに対応した前記誤差で検出結果を補正する段階とを有する。



【特許請求の範囲】

【請求項１】　パターン構造を有する領域が形成された物体を面位置検出手段に対して相対走査して、前記領域内の複数の検出ポイントの面位置を前記面位置検出手段で測定する面位置検出方法において、
前記面位置検出手段が面位置を検出する際の前記複数の検出ポイント間のパターン構造の違いにより生じる各検出ポイント毎の誤差を検出する段階と、
前記物体を前記面位置検出手段に対して相対走査して、前記面位置検出手段で前記領域内の前記複数の検出ポイントの面位置を検出する際、検出ポイント毎に該検出ポイントに対応した前記誤差で検出結果を補正する段階とを有することを特徴とする面位置検出方法。

【請求項２】　前記物体には、前記領域と同一のパターン構造を有する複数の領域が形成されており、前記物体を前記面位置検出手段に対して相対走査して、前記面位置検出手段で前記複数の領域内の前記複数の検出ポイントと同一箇所の面位置を検出する際、検出ポイント毎に該検出ポイントに対応した前記誤差で検出結果を補正する段階とを有することを特徴とする請求項１の面位置検出方法。

【請求項３】　前記誤差検出段階は、前記複数の各領域内であって同一箇所の面位置データの組毎に各々の面位置データに基づいて前記物体の面形状を各々検出する段階と、前記各面形状に基づいて前記誤差を検出する段階とを有することを特徴とする請求項２の面位置検出方法。

【請求項４】　レチクルとウエハを投影光学系に対し同期させて走査させるとともに前記投影光学系を介して前記レチクル上のパターンを前記ウエハ上に投影露光する際、前記ウエハ上のパターン構造を有する被露光領域内の走査方向に並んだ複数の検出ポイントの面位置を順次検出して前記被露光領域を前記投影光学系の像面位置に位置させる走査型露光方法において、
面位置を検出する際、前記複数の検出ポイント間のパターン構造の違いにより生じるの各検出ポイント毎の誤差を検出する段階と、
前記複数の検出ポイントの面位置を順次検出する際、検出ポイント毎に該検出ポイントに対応した前記誤差で検出結果を補正する段階とを有することを特徴とする走査型露光方法。

【請求項５】　前記ウエハには、前記被露光領域と同一のパターン構造を有する複数の被露光領域が形成されており、前記複数の検出ポイントと同一箇所のの面位置を順次検出する際、検出ポイント毎に該検出ポイントに対応した前記誤差で検出結果を補正する段階とを有することを特徴とする請求項４の走査型露光方法。

【請求項６】　前記誤差検出段階は、前記複数の各被露光領域内であって同一箇所の面位置データの組毎に各々の面位置データに基づいて前記ウエハの面形状を各々検出する段階と、前記各面形状に基づいて前記誤差を検出する段階とを有することを特徴とする請求項５の走査型露光方法。

【請求項７】　物体に対して斜入射する光束によって物体の面位置を検出する面位置検出手段によって、前記物体上に形成された同一のパターン構造を有する複数の領域の各領域内の同一箇所の面位置をそれぞれ検出して物体の面形状を検出する方法において、
前記面位置検出手段によって、前記領域の同一箇所の面位置を検出する第１検出段階と、
前記検出結果に基づいて前記物体を所定の位置に駆動する段階と、
前記物体を駆動後、前記面位置検出手段によって、再度前記領域の同一箇所の面位置を検出する第２検出段階と、
前記駆動の際の駆動量と前記第２検出段階の検出結果に基づいて前記各領域の面位置を算出する段階とを有することを特徴とする面形状検出方法。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は面位置検出方法に関し特にスリットスキャン方式（走査型露光方式）の露光装置において投影光学系の光軸方向に関するウエハー表面の位置や傾きを連続的に検出する面位置検出方法及び走査型露光方法に関する。

【０００２】

【従来の技術】最近のメモリーチップの大きさは露光装置の解像線幅及びセルサイズの縮小トレンドに対するメモリ容量の拡大トレンドの差から徐々に拡大傾向を示しており例えば２５６Ｍの第１世代では１４ｘ２５㎜程度と報告されている。

【０００３】このチップサイズでは現在クリティカルレイヤー用の露光装置として使用されている縮小投影露光装置(ステッパー)の直径３１㎜の露光域では１回の露光あたり１チップしか露光できず、スループットがあがらないためにより大きな露光面積を可能とする露光装置が必要とされている。大画面の露光装置としては、従来より、高スループットが要求されるラフレイヤー用の半導体素子露光装置或いはモニター等の大画面液晶表示素子の露光装置として反射投影露光装置が広く使用されている。これは円弧スリット状の照明光でマスクを直線走査しこれを同心反射ミラー光学系でウエハー上に一括露光するいわゆるマスク-ウエハー相対走査によるスリット・スキャン方式（走査型露光方式）の露光装置である。

【０００４】これらの装置におけるマスク像の焦点あわせは感光基板(フォトレジスト等が塗布されたウエハー或いはガラスプレート)の露光面を投影光学系の最良結像面に逐次あわせ込むために高さ計測とオートフォーカス・オートレベリングの補正駆動をスキャン露光中連続的におこなっている。

【0005】これらの装置における高さ及び面位置検出機構は例えばウエハー表面に光束を斜め上方より入射するいわゆる斜入射光学系を用いて感光基板からの反射光をセンサー上の位置ずれとして検知する方法やエアーマイクロセンサーや静電容量センサーなどのギャップセンサーを用いる方法などがありスキャン中の複数の高さ測定値から測定位置が露光スリット領域を通過するときの高さ及び傾きの補正駆動量を算出、補正するというものであった。

【0006】

【発明が解決しようとしている課題】現在使用されているスリット・スキャン方式の露光装置のコンセプトを256M以降に対応可能な解像力となる様,投影系を改良した場合次の問題が発生する。

【0007】即ち回路パターンの微細化に対応できる様に縮小投影系が高NA化されるに従い回路パターンの転写工程におけるフォーカスの許容深度はますます狭くなってくる。現状のラフ工程に使用されている露光装置では許容深度が5um以上確保されているためスキャン露光中に連続計測される計測値に含まれる計測誤差やチップ内段差の影響は無視できるが256M対応を考慮した場合その許容深度は1um以下となるため前記計測誤差やチップ内段差（チップ内のパターン構造）の影響を補正する必要がある。

【0008】従来の縮小投影露光装置においては感光基板上に同一パターン構造を有する複数のチップが配置されており、その表面形状は露光位置でほぼ再現されるためロット処理に先立ち先行のパイロットウエハーで試し焼きを行えば上記オフセットは補正することができる。即ち面に対するフォーカス検出系の各計測点のキャリブレーションを行うことができるが、露光領域内複数ポイントをスキャンしながら計測する上記スリット・スキャン方式の露光装置ではこのフォーカスセンサーのキャリブレーションを測定点毎に焼きにより求める場合例えばチップ内20ポイントの補正を行うと仮定すると顕微鏡で像質を確認する作業は前記縮小投影露光装置の場合の20倍もかかってしまい生産効率を大きく悪化させることになる。

【0009】またレジスト表面を確実にとらえる様にセンサーを構成したとしても次のような場合その表面に沿って補正を行った場合かえってデフォーカスが発生する場合がある。即ち、メモリーなどの露光域内の構成は大きく分けるとメモリーセルの部分と周辺回路の部分とからなり一般的にクリティカルな解像性能を要求される露光領域はメモリーセルの部分に集中している。256Mのチップを例にとるとクリティカルな線幅転写が要求されるメモリーセル領域とメモリーセル領域を分割する様にたて・よこに走るルールの緩い周辺回路部分からなっている。この境界領域を拡大したのが図4(a),(b)である。セル部分と周辺回路部分はCMP(chemical mechanical polishing)やリセスアレイ形成法などにより平坦化が進められているが1um程度の段差が残ってしまう。今図4(a)に示す様にこの領域をスキャンしながらZ方向の補正を計測値どうり行う場合、即ちスリットの露光像面をレジスト表面に常にトラッキングさせる場合、スリットのスキャン方向の幅即ち短辺が5㎜に対して周辺回路部分が2mmあるとすると段差がある周辺回路の両脇にあるメモリーセルの各々2mmの領域(図4(a)のハッチング部分)で1um程度のデフォーカスが発生することになる。周辺回路の線幅管理はメモリーセルのそれに比べ緩くなっているためフォーカス深度もそれに応じて拡大している。この点を考慮すれば実段差（パターン構造）に露光像面を追従させることは好ましくなく段差データを補正量として管理する方が精度的に有利であると考えられるが現状ではオフセット管理および補正の方法が確立されていない。

【0010】

【課題を解決するための手段】本発明は前記した従来の問題点に鑑みてなされたものであり、その目的は多点のフォーカス計測系のキャリブレーションを行いウエハー表面の位置を高精度に検出する事ができる面位置検出方法を提供する事にあり　特にスリットスキャン露光方式における高精度の面位置検出方法を提供することにある。

【0011】本発明の面位置検出方法のある形態は、パターン構造を有する領域が形成された物体を面位置検出手段に対して相対走査して、前記領域内の複数の検出ポイントの面位置を前記面位置検出手段で測定する面位置検出方法において、前記面位置検出手段が面位置を検出する際の前記複数の検出ポイント間のパターン構造の違いにより生じる各検出ポイント毎の誤差を検出する段階と、前記物体を前記面位置検出手段に対して相対走査して、前記面位置検出手段で前記領域内の前記複数の検出ポイントの面位置を検出する際、検出ポイント毎に該検出ポイントに対応した前記誤差で検出結果を補正する段階とを有することを特徴とする。

【0012】前記面位置検出方法の好ましい形態は、前記物体には、前記領域と同一のパターン構造を有する複数の領域が形成されており、前記物体を前記面位置検出手段に対して相対走査して、前記面位置検出手段で前記複数の領域内の前記複数の検出ポイントと同一箇所の面位置を検出する際、検出ポイント毎に該検出ポイントに対応した前記誤差で検出結果を補正する段階とを有することを特徴とする。

【0013】前記誤差検出段階の好ましい形態は、前記複数の各領域内であって同一箇所の面位置データの組毎に各々の面位置データに基づいて前記物体の面形状を各々検出する段階と、前記各面形状に基づいて前記誤差を検出する段階とを有することを特徴とする。

【0014】本発明の走査型露光方法のある形態は、レ

チクルとウエハを投影光学系に対し同期させて走査させるとともに前記投影光学系を介して前記レチクル上のパターンを前記ウエハ上に投影露光する際、前記ウエハ上のパターン構造を有する被露光領域内の走査方向に並んだ複数の検出ポイントの面位置を順次検出して前記被露光領域を前記投影光学系の像面位置に位置させる走査型露光方法において、面位置を検出する際、前記複数の検出ポイント間のパターン構造の違いにより生じるの各検出ポイント毎の誤差を検出する段階と、前記複数の検出ポイントの面位置を順次検出する際、検出ポイント毎に該検出ポイントに対応した前記誤差で検出結果を補正する段階とを有することを特徴とする。

【0015】前記走査型露光方法の好ましい形態は、前記ウエハには、前記被露光領域と同一のパターン構造を有する複数の被露光領域が形成されており、前記複数の検出ポイントと同一箇所のの面位置を順次検出する際、検出ポイント毎に該検出ポイントに対応した前記誤差で検出結果を補正する段階とを有することを特徴とする。

【0016】前記誤差検出段階の好ましい形態は、前記複数の各被露光領域内であって同一箇所の面位置データの組毎に各々の面位置データに基づいて前記ウエハの面形状を各々検出する段階と、前記各面形状に基づいて前記誤差を検出する段階とを有することを特徴とする。

【0017】本発明の面形状検出方法のある形態は、物体に対して斜入射する光束によって物体の面位置を検出する面位置検出手段によって、前記物体上に形成された同一のパターン構造を有する複数の領域の各領域内の同一箇所の面位置をそれぞれ検出して物体の面形状を検出する方法において、前記面位置検出手段によって、前記領域の同一箇所の面位置を検出する第1検出段階と、前記検出結果に基づいて前記物体を所定の位置に駆動する段階と、前記物体を駆動後、前記面位置検出手段によって、再度前記領域の同一箇所の面位置を検出する第2検出段階と、前記駆動の際の駆動量と前記第2検出段階の検出結果に基づいて前記各領域の面位置を算出する段階とを有することを特徴とする。

【0018】

【発明の実施の形態】図1は本発明の面位置検出方法を用いるスリット・スキャン方式の投影露光装置の部分概略図である。

【0019】図1において1は縮小投影レンズであり、その光軸は図中ＡＸで示され、またその像面は図中Ｚ方向と垂直な関係にある。レチクル2はレチクルステージ3上に保持され、レチクル2のパターンは縮小投影レンズの倍率で1/4ないし1/2に縮小投影されその像面に像を形成する。4は表面にレジストが塗布されたウエハーであり、先の露光工程で形成された同一のパターン構造を有する多数個の被露光領域(ショット)が配列されている。5はウエハーを載置するステージで、ウエハー4をウエハーステージ5に吸着・固定するチャック、X軸方向とＹ軸方向に各々水平移動可能なＸＹステージ、投影レンズ1の光軸（ＡＸ）方向であるＺ軸方向への移動やX軸、Ｙ軸の回りに回転可能なレベリングステージ、Ｚ軸の回りに回転可能な回転ステージにより構成されており、レチクルパターン像をウエハー上の被露光領域に合致させるための６軸補正系を構成している。

【0020】図1における１０から１９はウエハー４の表面位置及び傾きを検出するために設けた検出光学系の各要素を示している。１０は光源であり、白色ランプ、または相異なる複数のピーク波長を持つ高輝度発光ダイオードの光を照射する様に構成された照明ユニットよりなっている。１１はコリメータレンズであり光源１０からの光束を断面の強度分布がほぼ均一の平行光束として射出している。１２はプリズム形状のスリット部材であり一対のプリズムを互いの斜面が相対する様に貼り合わせており、この貼り合わせ面に複数の開口(例えば６つのピンホール)をクロム等の遮光膜を利用して設けている。１３は両テレセントリック系の光学系で、スリット部材１２の複数のピンホールを通過した独立の６つの光束をミラー１４を介してウエハー４面上の６つの測定点に導光している。図1では2光束のみ図示しているが各光束は紙面垂直方向に各々３光束もっている。このときレンズ系１３に対してピンホールの形成されている平面とウエハー４の表面を含む平面とはシャインプルーフの条件(Scheinmpflug's condition)を満足するように設定している。

【0021】本実施例において光照射手段からの各光束のウエハー４面上への入射角Φ(ウエハー面にたてた垂線即ち光軸となす角)はΦ=７０゜以上である。ウエハー４面上には図3に示す様に、同一パターン構造を有する複数個の被露光領域(ショット)が配列されている。レンズ系１３を通過した６つの光束は図2に示す様にパターン領域の互いに独立した各測定点に入射・結像している。また６つの測定点がウエハー４面内で互いに独立して観察されるようにX方向(スキャン方向5a)からＸＹ平面内でΘ゜(例えば２２.５゜)回転させた方向より入射させている。

【0022】これにより本出願人が特願平3-157822号で提案している様に各要素の空間的配置を適切にし面位置情報の高精度な検出を容易にしている。

【0023】次にウエハー４からの反射光束を検出する側、即ち１５から１９の各構成について説明する。１６は両テレセントリック系の受光光学系でウエハー４面からの６つの反射光束をミラー１５を介して受光している。受光光学系１６内に設けたストッパー絞り１７は6つの各測定点に対して共通に設けられておりウエハー４上に存在する回路パターンによって発生する高次の回折光(ノイズ光)をカットしている。両テレセントリック系の受光光学系１６を通過した光束はその光軸が互いに平行となっており補正光学系群１８の６個の個別の補正レ

ンズにより光電変換手段群１９の検出面に、互いに同一の大きさのスポット光となる様に再結像させている。

【００２４】またこの受光する側（１６から１８）はウエハー４面上の各測定点と光電変換手段群１９の検出面とが、互いに共役となるように倒れ補正を行っているために各測定点の局所的な傾きにより検出面でのピンホール像の位置が変化することはなく各測定点の光軸方向ＡＸでの高さ変化に応答して検出面上でピンホール像が変化するように構成されている。

【００２５】ここで光電変換手段群１９は6個の１次元ＣＣＤラインセンサーにより構成している。これは次の点で従来の２次元センサーの構成よりも有利である。まず１８の補正光学系群を構成する上で光電変換手段を分離する事により各光学部材やメカ的なホルダーの配置の自由度が大きくなる。また検出の分解能を向上させるにはミラー１５から補正光学系群１８までの光学倍率を大きくする必要があるがこの点でも光路を分割して個別のセンサーに入射させる構成とした方が部材をコンパクトにまとめることが可能である。さらにスリット・スキャン方式では露光中のフォーカス連続計測が不可欠となり計測時間の短縮が絶対課題となるが従来の２次元ＣＣＤセンサーでは必要以上のデータを読み出しているのもその一因であるが１次元ＣＣＤセンサーの１０倍以上の読み出し時間を必要とする。

【００２６】次にスリット・スキャン方式の露光システムについて説明する。

【００２７】図１に示す様にレチクル２はレチクルステージ３に吸着・固定された後投影レンズ１の光軸ＡＸと垂直な面内で図１に示す矢印３ａ（X軸方向）方向に一定速度でスキャンするとともに矢印３ａと直交する方向（Y軸方向：紙面に垂直）には常に目標座標位置を維持してスキャンする様に補正駆動される。このレチクルステージのX方向及びY方向の位置情報は図１のレチクルステージに固定されたＸＹバーミラー２０へ外部からレチクル干渉系（ＸＹ）２１から複数のレーザービームが照射されることにより常時計測されている。

【００２８】露光照明光学系6はエキシマレーザー等のパルス光を発生する光源を使用し不図示のビーム整形光学系、オプティカルインテグレイター、コリメータ及びミラー等の部材で構成され、遠紫外領域のパルス光を効率的に透過或いは反射する材料で形成されている。ビーム整形光学系は入射ビームの断面形状（寸法含む）を所望の形に整形するためのものであり、オプティカル・インテグレータは光束の配光特性を均一にしてレチクル２を均一照度で照明するためのものである。露光照明光学系６内の不図示のマスキングブレードによりチップサイズに対応して矩形の照明領域が設定され、その照明領域で部分照明されたレチクル２上のパターンが投影レンズ１を介してレジストが塗布されたウエハー４上に投影される。

【００２９】図1に示すメイン制御部２７はレチクル２のスリット像をウエハー４の所定領域にＸＹ面内の位置（X，Yの位置，及びZ軸の回りの回転Θ）とＺ方向の位置（Ｘ，Ｙ各軸にの回りの回転α，β及びZ軸上の高さＺ）を調整しながら、レチクルとウエハを投影光学系に対し同期させて走査させるとともに縮小投影光学系１を介してレチクル２上のパターンをウエハ上に投影露光するスキャン露光を行う様に全系をコントロールしている。即ちレチクル上のパターンのＸＹ面内での位置あわせはレチクル干渉計２１とウエハーステージ干渉計２４の位置データと不図示のアライメント顕微鏡から得られるウエハーの位置データから制御データを算出し、レチクル位置制御系２２及びウエハー位置制御系２５をコントロールすることにより実現している。

【００３０】レチクルステージ3を図1　矢印3aの方向に走査する場合ウエハーステージ５は図１の矢印5ａの方向に投影レンズの縮小倍率分だけ補正されたスピードで走査される。レチクルステージ3の走査スピードは露光照明光学系６内の不図示のマスキングブレードのスキャン（走査）方向の幅とウエハー４の表面に塗布されたレジストの感度からスループットが有利となるように決定される。

【００３１】レチクル上のパターンのZ軸方向の位置合わせ即ち像面への位置合わせはウエハー４の高さデータを検出する面位置検出系２６の演算結果をもとにウエハーステージ内のレベリングステージへの制御をウエハー位置制御系２５を介しておこなっている。即ちスキャン方向に対してスリット近傍に配置されたウエハー高さ測定用スポット光３点の高さデータからスキャン方向と垂直方向の傾き及び光軸ＡＸ方向の高さを計算して露光位置での最適像面位置への補正量を求め補正を行っている。

【００３２】次に、本発明の面位置検出方法によりウエハー４の被露光領域の位置を検出する方法をのべる。

【００３３】ウエハー４の被露光領域のZ方向の位置即ち像面位置に対する位置（Z）および傾き（α，β）のずれを検出するためにはウエハー４の表面を正確に計測するとともに照明領域形状と被露光領域のパターン構造（実際の段差）との関係も考慮しなければならない。前者の表面を正確に計測するという目的に対して光学方式の検出系を用いた場合次のような検出誤差の要因が考えられる。即ちウエハー４のレジスト表面で反射した光とウエハー４の基板面で反射した光との干渉の影響である。その影響は広い意味でのパターン構造である基板面の材質により変化しAlなどの高反射の配線材料では無視できない量となる。また静電容量センサーをウエハー面位置検出センサーとして使用した場合においては、高速素子や発光ダイオードの基板として使用するGaAsウエハーでは誘電体であるがためSiウエハーとは異なり大きな計測オフセットを持つことが知られている。また計測誤差の他

の例として被露光領域のパターン構造(実際の段差)の考慮をあげたが、これは先にも述べたとうり実段差に露光像面を追従させることは好ましくなく、図４(b)に示すように段差データを補正量として管理する方が精度的に有利である。

【００３４】その補正方法の概略を図５のフローチャートを用いて説明する。step101でスタート指令を受け、step102でウエハーをステージ上に搬入・チャックに吸着固定する。その後チップの被露光域内の表面形状（複数の面位置）を測定するために、step103で図３に示すような、斜線の複数のサンプルショット領域にてプリスキャン測定（実際にスキャンさせながら各被露光領域内の複数箇所の面位置を検出する）をおこなう。その後、測定された面位置検出値（面位置データ）を用いて、スキャン露光中の面位置検出値を最適露光像面位置までの距離に補正するための補正値（パターン構造に依存する誤差）をstep104にて算出する。補正値の算出が完了するとstep105にてスキャン露光中、各面位置を検出する検出ポイントでの面位置検出値を、検出ポイントのパターン構造に対応した前記補正値で補正し、補正された面位置検出値に基づいて、被露光領域を露光像面に合わせ露光を行う。

【００３５】このプリスキャン測定で求められた補正値は、パターン構造（被露光領域内の実際の段差、基板の材質）に依存する。従って、同一ロットもしくは同一工程を経たウエハ同士では、パターン構造が同一と考えられるので、最初の少なくとも一枚のでも求めた補正値を、以後のウエハに適用することが可能である。そのフローチャートを図６に示す。図６に示したフローチャートの様なシーケンスによって、大幅なスループットが期待できる。

【００３６】以下、パターン構造（被露光領域内の実際の段差、基板の材質）に依存する計測誤差要因をスキャン露光中の面位置検出値から補正するためのオフセット値（補正値）の計測方法を詳細に説明する。

【００３７】ウエハーの面位置及び傾きを検出する際に問題となるパターン構造（被露光領域内の実際の段差、基板の材質）に依存する誤差を面位置計測データから補正するオフセット値を導出する方法を以下図５のフローチャートを使用して説明する。

【００３８】まず上記オフセット値を算出するために予めサンプルショットとしてスキャン計測すべき被露光領域を複数個決めておく。これはウエハーの面精度の影響を受けにくい様ウエハー上中心対称かつ全面の情報を効率的に得られる例えば図３に示す様な斜線の被露光領域の位置を選択することが望ましい。この配置はＣＭＰなどの研磨工程やその他の処理工程等を考慮した場合ウエハーの円形状という特殊性から変形が中心対称的に発生することが想定されるからである。まずstep1でウエハー４をウエハーステージ５のチャック上に載せ吸着・固定する。その後step2で不図示のAA顕微鏡下へ特定ショットのアライメントマークを移動・AA顕微鏡のフォーカス補正を行いアライメントマークの位置を計測する。この測定を複数(ｇショット)のショットで測定し得られるアライメントデータからウエハー上の全露光位置のショットの配列データを補正し各被露光領域がスキャン露光中正しくレチクルと位置合わせできるような状態にしておく。この状態にしておけば各被露光位置のパターンは同一のレチクルにて処理されているため各露光位置におけるステージ座標で定義した第ｊ回目の面位置計測時のパターン構造はアライメント精度の範囲内で完全に一致する事が期待され、実際各測定ごとにほぼ一定の計測データを示すことが確認されている。このステップで得られた配列情報に従って以下のサンプルショット移動及びショット内のスキャンが実行されるためショット間でのショット内各スキャン位置でのチップ内形状はアライメント精度の範囲内で同一パターン構造の同一箇所を測定していることになる。またこの測定の段階でウエハー全面の傾斜成分をフォーカス検出系で測定しておきstep3に入る前にウエハー全体の傾斜成分を補正するようにウエハーステージ５内部のレベリングステージを補正駆動しておく。

【００３９】このstep2でのショット配列補正が確定すると、step3でオフセット計測のシーケンスに移行していく。まず予め決定されたサンプルショットSi(i=1～m)内　第１計測ポイント（検出ポイント）位置へウエハー系のレーザー干渉計24の出力信号に基づいて移動する(step3,step4)。そこで被露光領域内第ｊ計測ポイントでのウエハー表面での面位置計測データ即ちウエハー表面の光軸AX方向の位置Zjk(k=1～ｐ)を検出光学系(10～19)で検出することになるが、実際の露光時にはほぼ投影レンズの像面近傍で計測されるためこのオフセット測定の際も像面近傍で計測する必要がある。今ウエハーの面形状が変形をうけていない場合、ウエハー全面の面形状を知るためにはウエハーの高さを固定(レベリングステージの高さ固定)してウエハーステージをＸ，Ｙ方向にステップ・位置決めを行い、逐次面位置測定を行えばよい。しかるにウエハーが複数の処理工程を経て加工が進んでくるとウエハー全面の形状は図８(a),(b)に示すような凸または凹の形状を持つ傾向がある。このような全体的に変形を受けたウエハーにおいて斜入射の検出光学系を用いた場合、図８(a)に示す様にウエハーの高さを固定したままフォーカス計測を進めると検出用光ビームの入射位置はウエハー形状の変化即ち高さ変化に応じて横方向にシフトしてしまい本来必要としている露光像面近傍での観察パターンとは異なる位置を読んでいる可能性が高くなる。この問題の解決方法として図８(b)に示す様に各計測位置でＺステージの位置を像面近傍位置へ補正する方法をとっている。このシーケンスを図７に戻って説明する。まずstep5にてＸＹ平面内で露光位置と

同一の位置へ位置決めされた状態で不図示のレベリングステージの位置検出系でレベリングステージの位置を検出して、ウエハーステージ5内のレベリングステージの位置(Z0, α0, β0)を記憶(最初のサンプルショットの第1ポイントでのみ測定その後の各ショット、各ポイントでの補正計算にはこのデータを使用)した後、ウエハー表面での面位置計測データを求め、その値を用いて像面位置までウエハー表面を移動してZ補正駆動をおこなう。この像面位置までのウエハー表面のZ補正駆動を行うことにより前記検出用光ビームの横方向シフトの問題はなくなり(図8(b))補正後のレベリングステージの位置(Zj, α0, β0)とその位置での面位置計測データ即ちウエハー表面の光軸AX方向の位置Z0jk(k=1～p)のデータから、Zjk(k=1～p)=Z0jk+Zj-Z0;と計算する。ここでは補正量(Zj-Z0)をレベリングステージのZ方向の位置検出結果で行う例を説明したが、計測値Z0jkの値を基にレベリングステージの補正駆動を行っているのでレベリングステージの駆動誤差が無視できる場合、補正駆動前の計測値Z0jkの値と補正駆動後のZ0jkの値を加算していくことによっても実現可能である。この位置Z0jk(k=1～p)に対応する信号がp個のCCDリニアセンサーで構成された検出部19からフォーカス信号処理部26へ入力され上記補正計算を実施した後、第j計測ポイントでの計測値としてメモリーされる。またstep6にてこの位置でのウエハーステージのポジション(X,Y)も同時にメモリーする。

【0040】step7では同様の測定をサンプルショット内全計測ポイント(j=1～n)での計測が終了したか判定し終了していなければstep4で次の計測ポイントへ移動し同様の計測をくりかえす。終了した場合step8で全サンプルショット(i=1～m)での計測が終了したか判定し終了していなけれstep3へ移動する。

【0041】step8の判定で全サンプルショット内全サンプル計測ポイントでの計測が終了したと判定された場合step9にて被露光位置内計測位置での全計測ポイント、全センサー位置でのオフセット補正値Cjkを計算する。この計算に関しては本出願人が先に提案した特公平6-52707号にある面位置検出方法においてステッパーなどで用いられる被露光位置内単一ポイント計測の例を説明しているが今回提案する検出方法はそれをスキャン方式の露光装置での応用を考慮し高精度かつ被露光領域内の複数ポイントでの計測オフセット補正として使用できるように次のように改良している。即ち本オフセット計測シーケンスで得られる被露光位置内の計測ポイントjでの計測センサーkの計測値Zjkによりn x p個のウエハーの面形状を示す面形状関数Fnp(x,y)(各面形状関数のデータポイント数はサンプルショットSi(i=1～m)のmポイント)が決定される。これらの面形状関数Fnp(x,y)の曲面の次数や展開式は所定の多項式の形で予め定めておき、各面のオフセット量を求めるために測定値Zjkを面位置データとして用い最小自乗法によりFnpの係数即ちオフセット補正値を求める。

【0042】具体的には、

$$\iint (Fjk(x,y)-Zjk(x,y))2dxdy=0(j=1\sim n,k=1\sim p)$$

なる式を満足する様な定数項Cjkを求めることになる。

【0043】この補正値導出のシーケンスをサンプルショットm=3,走査方向の計測ポイントj=3,計測センサーk=3の場合を　図9(a)を用いて説明する。まず簡略化のためにウエハーの平面度は1次元的であり平面の式、aX+bY+cZ=d　で　b=c=0と仮定する。

【0044】今ウエハー上の断面構造は図9(a)にあるように計測ポイントj=1では計測センサーk=1,2が同一の高さに対しk=3のみ段差が測定される構造(例えばメモリーセル領域中下地材質が異なる部分k=1,2で干渉の影響により基板側に計測値がシフトしている)がj=3でも繰り返されており、j=2の計測ポイントでは、k=2のみ段差が大きい測定値が得られる構造(例えばメモリーセルに対する周辺回路領域)になっているとする。この被露光領域のパターンはサンプルショットをm=1～3で測定した場合図のようにアライメント精度の範囲内で合致しているためその面位置測定値Zjkも再現する。

【0045】このようにして得られた27個の計測値Zjkから次のような計算処理によりオフセットCjkをもとめる。即ち図9(a)のZ21データを基準(この位置の投影レンズ像面とのオフセットC21は例えば先行ウエハーで実際に露光などにより求める)として他のCjkを求めることにする。今m=1～3のZ21計測データで作る面F21を基準すなわち定数項0として扱い、たとえば周辺回路領域に相当するZ22のオフセットC22を求めるには図9(b)に示す様にZ22のm=1～3の計測値で求められる面形状関数F22と前記F21とのウエハーの形状に関する差分を求めるとよい。

【0046】ここでの差分は一般の平面の式でいわれるd(切片)の差分量でありその値は図のC22として算出可能である。また同様にして干渉の影響でシフトしているZ11のC11に関してもF21とF11との切片の差分として求めることが可能である。同様の計算を他のCjkの算出時にも行いその結果をメモリーに記憶する。

【0047】引き続き各被露光位置でのフォーカス位置計測・Cjkによる計測値補正・レベリングステージの位置補正の過程を図7及び図10にて説明する。今図7のstep11,12で第Nショットの第1計測ポイントに到達した位置即ち図10(a)に示すように第N-1ショットを露光中にフォーカス計測ビームが第Nショット第1計測ポイントにかかる位置へウエハーステージ5が移動している状態を説明する。step12で第Nショット、第1計測ポイントでのZjk計測値具体的には図10(a)CR1,CR2,CR3の計測ビームに対する光電変換手段群19のうち3つのCCDリニアセンサーからの検出信号をフォーカス信号処理部26にて処理しその高さデータZ11,Z12,Z

13をもとめる。この測定データには干渉による計測誤差や段差によるオフセット誤差を含んでいるためstep9で求めたCjkの補正データを使用し次のように差分を求めることによりウエハー本来の面位置計測データZTjkをもとめる。

【0048】ZTjk=Zjk－Cjk

ここで算出されたZTjkはレジスト表面に起因する計測オフセットが補正された露光エリア内のウエハーの変形分のみを含んでおりこの面位置データを基にstep14で最小自乗平面を算出する。

【0049】次にstep15で投影レンズ1の露光像面と前記最小自乗平面との差分及びレベリングステージのＺjk測定時の位置と現在位置との差分を補正する様にウエハーステージ5を光軸方向と傾き方向に補正駆動しウエハー露光エリアを縮小投影レンズ像面に一致させる。以上の様に第ｊ計測ポイントの補正駆動が終了するとstep16で全計測ポイントが終了したか確認しj=nとなるまで計測・補正駆動を並列にくりかえす。

【0050】即ち図１０（b）の状態ではｊ＝１のデータで補正を行い同時にｊ＝２のポイントでフォーカスの計測およびオフセット補正をおこなう。その補正データを使用して図１０（c）の位置にスキャンしてきた段階ではｊ＝２のデータで補正を行い、同時にｊ＝３のポイントでフォーカスの計測およびオフセット補正をおこなう。その補正データを使用して図１０（ｄ）の位置にスキャンしてきた段階ではｊ＝３のデータで補正を行う。ｊ＝nポイントまで計測・補正が完了するとstep17でウエハー上全露光ショットの露光が終了したかを確認し、N=wとなるまで各ショット　スキャン露光をくりかえす。

【0051】以上説明したウエハーの面位置及び傾きを検出する際に問題となる計測誤差やチップ内段差のオフセット値を計測データから補正値として導出するシーケンス即ち多点フォーカス検出機構でのセンサー間キャリブレーションは形成されるパターンが異なる各工程で行うことになるがロット内の１枚のみで測定するだけで十分であり、その後の同一工程に関してはロット先頭の１枚で求めたオフセットＣｉｊをメモリーに記憶しておいて各フォーカス計測・補正時に使用する事により本来の目的は十分実現可能でありスループットを低下させることなく高精度のレベリング補正及び露光が実施される。

【0052】上記実施例ではウエハー上のパターンに依存したオフセットを補正するシーケンスを例にとったが上記例に限定されるものではなく例えば多点フォーカスの原点をキャリブレーションする際も従来は高精度の平面を用意したり実際に露光により求めたりしていたが今回のシーケンスをパターン加工されていないウエハーで実施する事によりフォーカスセンサーの取り付け位置オフセットを簡単に求めることが可能である。また面のみに限定されるものでもなく１点の高さ検出センサーでスキャンフォーカスを行う場合スキャン内の基準面例えばメモリーセルの表面を常に像面位置に固定したい場合も同様のオフセット補正シーケンスを実行することにより可能である。

【0053】また上記実施例では被露光領域内でメモリーセルなどフォーカス深度が最も厳しい１ポイントを事前に露光してベストフォーカスを求める様にしたが１ポイントに限るものではなく、また装置要因即ちレンズの環境による変化を求めるため最低１ポイント測定し被露光領域内で個別にフォーカス補正位置を変化した方がよい場合即ちロジックデバイスなどで部分的に表面高さが異なる場合にはその設計値から上記面位置データオフセットCijのデータを補正してもよい。具体的には照明領域スリットの幅を考慮しCijで定義される２次元マップからオフセットを変更すべき領域が大きい場合その段差分でCijを補正する。

【0054】

【発明の効果】以上説明したように本発明によればウエハー上の被露光領域のICパターンに起因する検出誤差及び表面の段差構造を、露光に先立ち最もフォーカス値が高精度に測定される条件でプリスキャンすることにより計測し、かつその被露光領域内で最もフォーカス精度が要求される部分の高さを基準としてオフセット管理することによりスキャン露光中に計測されるフォーカス計測値の検出誤差をリアルタイムで補正することができる。

【0055】従ってスリットスキャン露光装置などで工程が進み表面に段差ができてきたウエハーにおいてもその段差に左右されることなくウエハー本来の歪み成分の補正を行い被露光領域を確実に焦点深度内に位置づけることができる。このためより良好なパターン転写を行い２５６Ｍ以降のより集積度の高い回路を安定して作成する事ができるという優れた効果がある。

【図面の簡単な説明】

【図１】本発明の面位置検出方法を用いるスリットスキャン方式の投影露光装置の部分的概略図。

【図２】検出光学系による面位置検出での露光スリットと各測定点の位置関係を示す説明図。

【図３】ウエハー上の被露光領域の配列状態と本発明でプリスキャンを行うサンプルショットの選択の例を示す平面図。

【図４】被露光領域スキャン中のIC表面トポグラフィーを示す被露光領域とフォーカス制御されたスリット露光の像面位置の関係を説明する説明図。

【図５】本発明の面位置検出方法を用いたオフセットの測定及び各ショットでの露光時の面位置補正駆動のシーケンスの概略例を示すフローチャート図。

【図６】本発明の面位置検出を用いたロット着工のシーケンス例を示すフローチャート図。

【図７】本発明の面位置検出方法を用いたオフセットの測定及び各ショットでの露光時の面位置補正駆動のシー

ケンスの１例を示すフローチャート図。

【図８】本発明の高精度にフォーカスオフセットを算出するための補正駆動を行う必要性を説明する説明図。

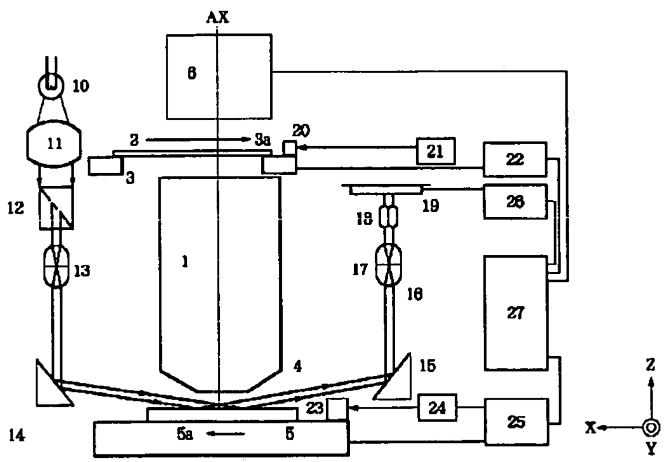
【図９】本発明のオフセット算出の方法を具体的に説明する説明図。

【図１０】本発明の面位置検出方法を用いたスリットスキャン露光時のスリットと面位置検出センサーの位置関係を説明する説明図。

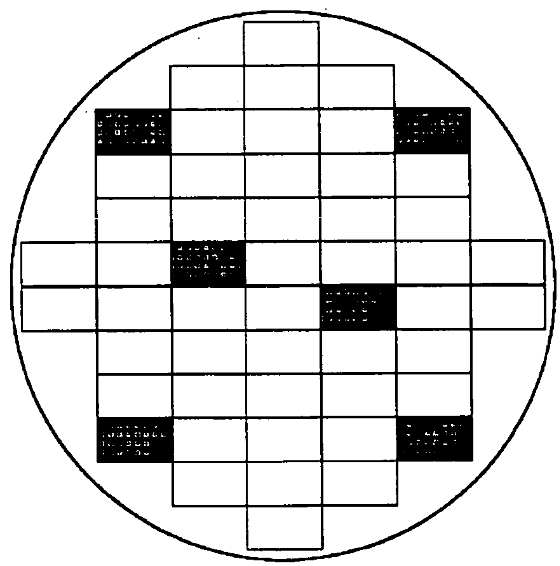
【符号の説明】

１　縮小投影レンズ
２　レチクル
３　レチクルステージ
４　ウエハー
５　ウエハーステージ
６　露光照明光学系
１０　光源
１１　コリメータレンズ
１２　プリズム形状のスリット部材
１４　折り曲げミラー
１５　折り曲げミラー
１９　光電変換手段群
２１　レチクルステージ干渉計
２２　レチクル位置制御系
２４　ウエハーステージ干渉計
２５　ウエハー位置制御系
２６　面位置検出系
２７　メイン制御部

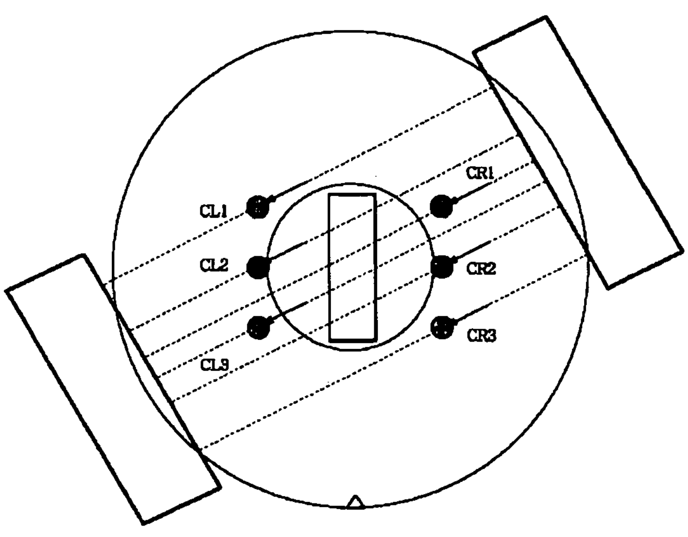
【図１】



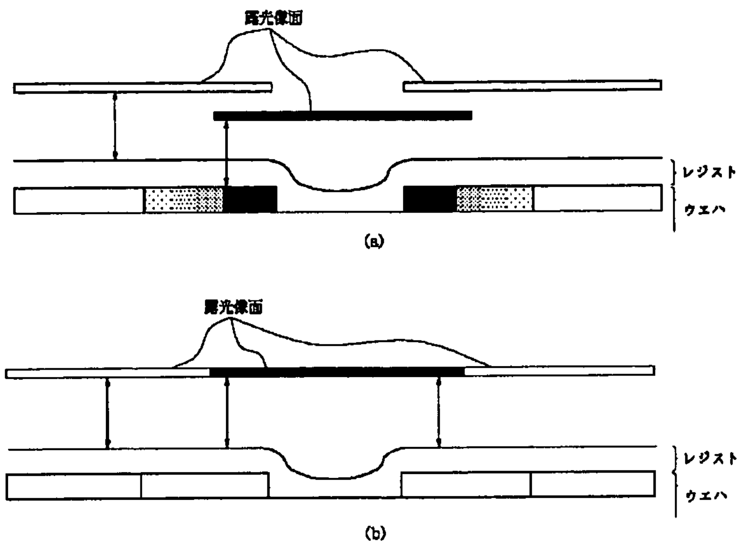
【図３】



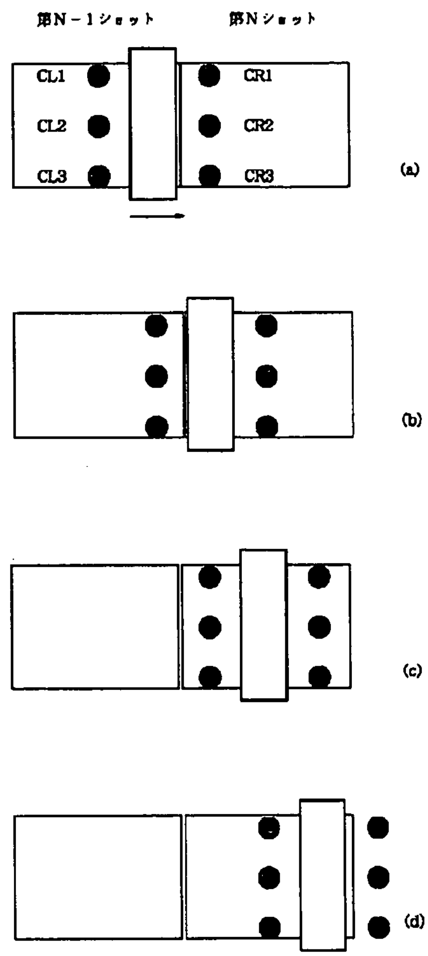
【図２】



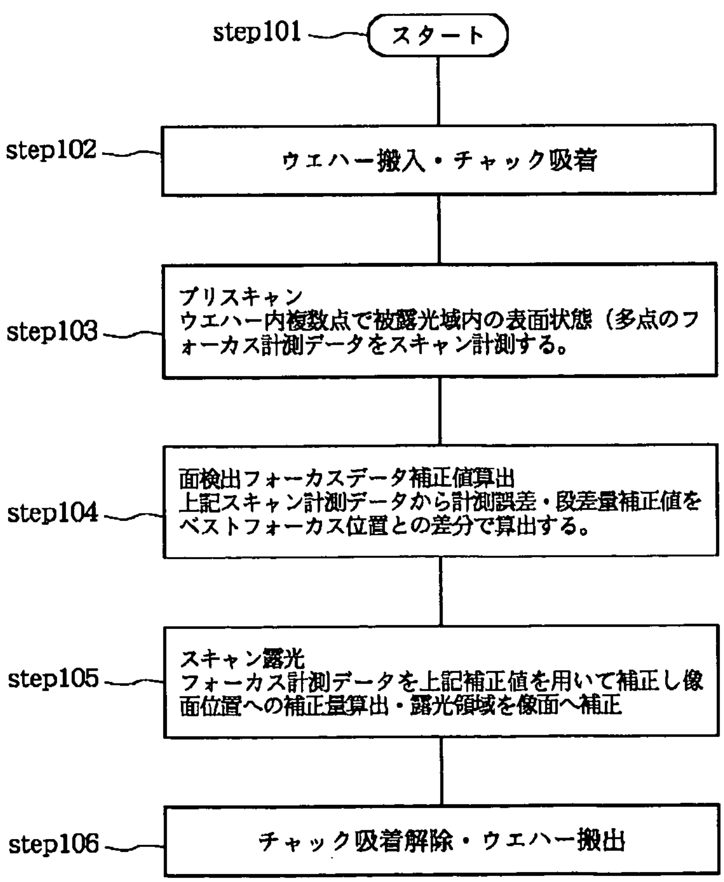
【図4】


露光像面
レジスト
ウエハ
(a)
露光像面
レジスト
ウエハ
(b)

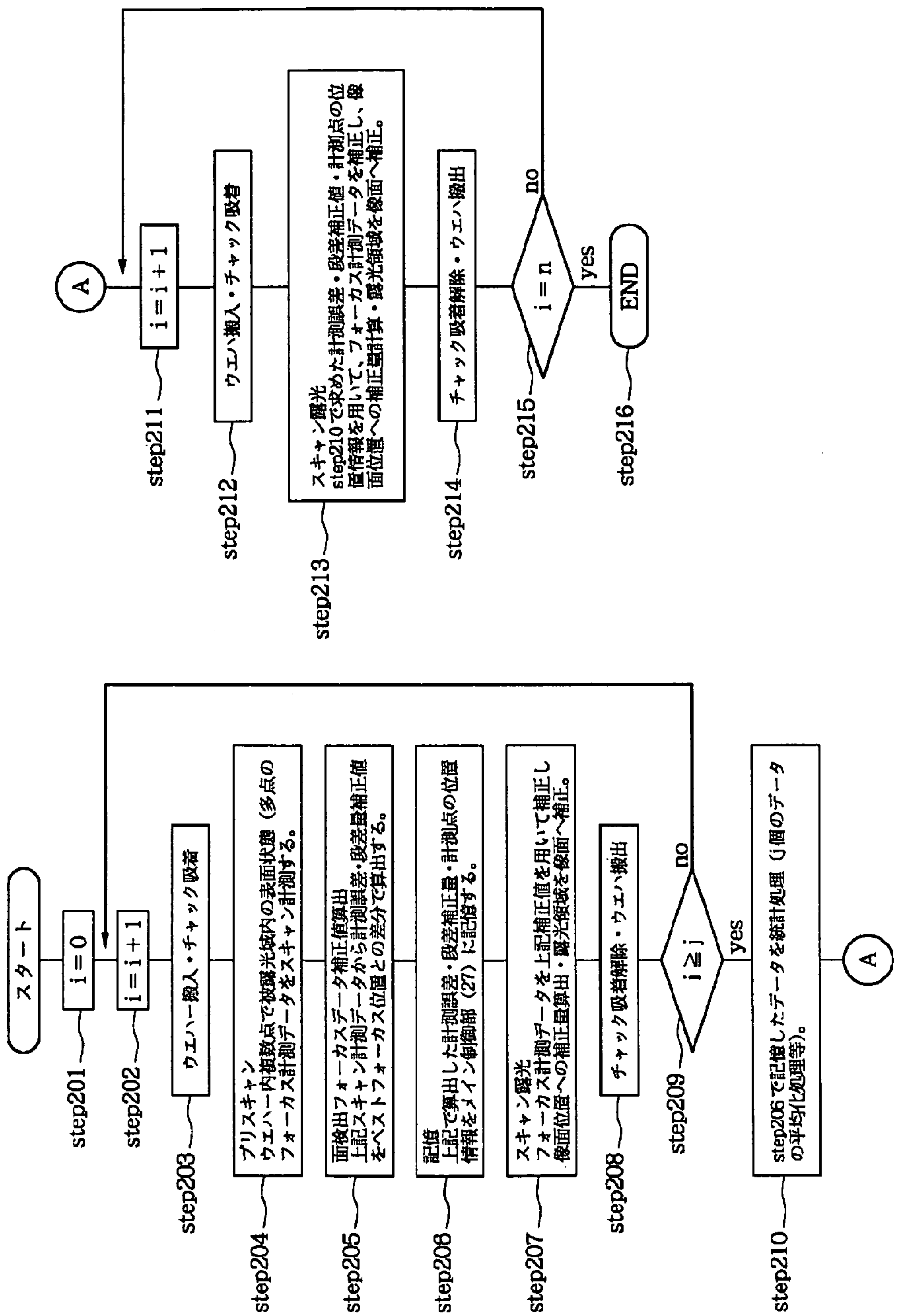
【図10】


第N－1ショット
第Nショット
CL1
CL2
CL3
CR1
CR2
CR3
(a)
(b)
(c)
(d)

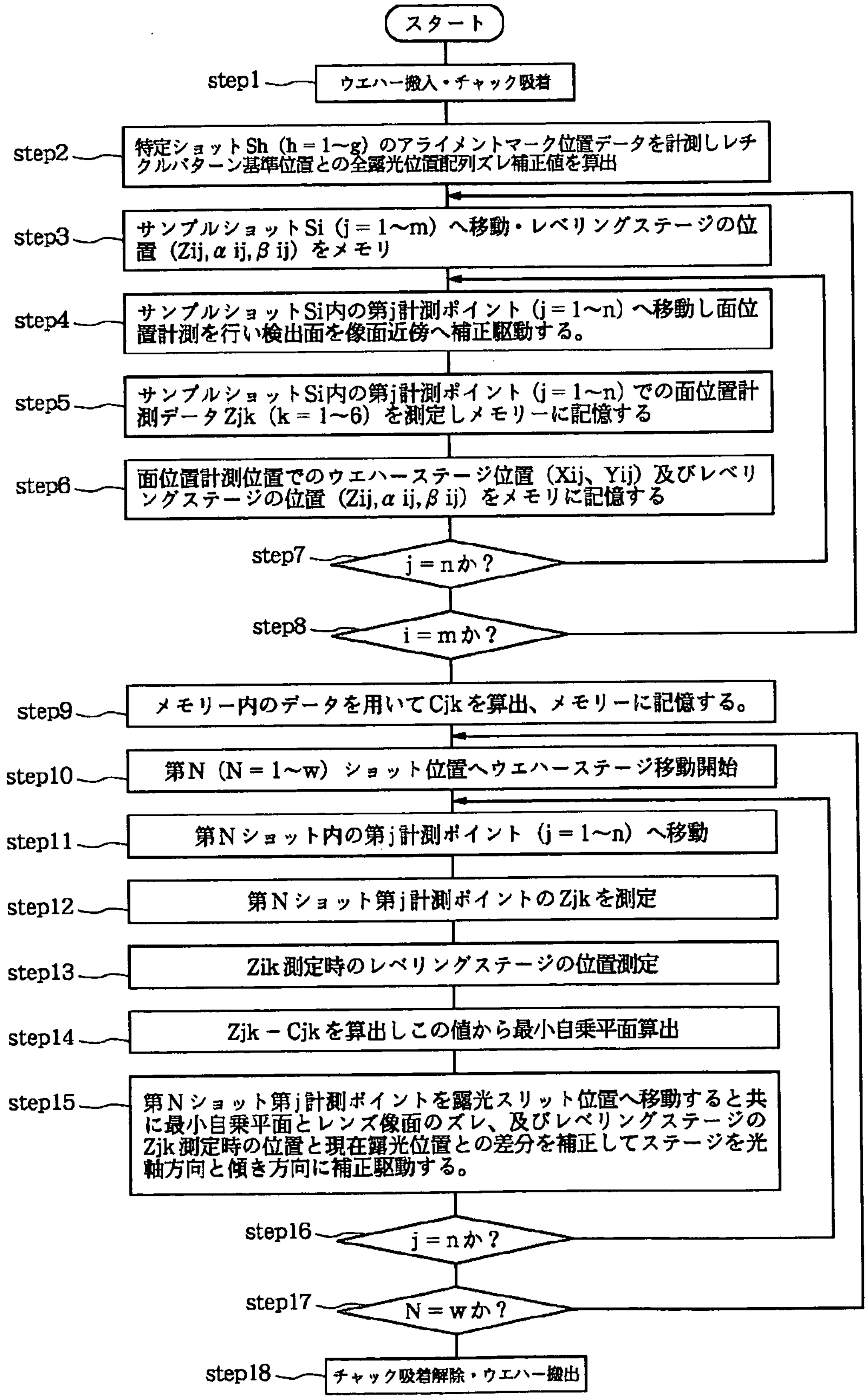
【図5】


step101
スタート
step102
ウエハー搬入・チャック吸着
step103
プリスキャン
ウエハー内複数点で被露光域内の表面状態（多点のフォーカス計測データをスキャン計測する。
step104
面検出フォーカスデータ補正値算出
上記スキャン計測データから計測誤差・段差量補正値をベストフォーカス位置との差分で算出する。
step105
スキャン露光
フォーカス計測データを上記補正値を用いて補正し像面位置への補正量算出・露光領域を像面へ補正
step106
チャック吸着解除・ウエハー搬出

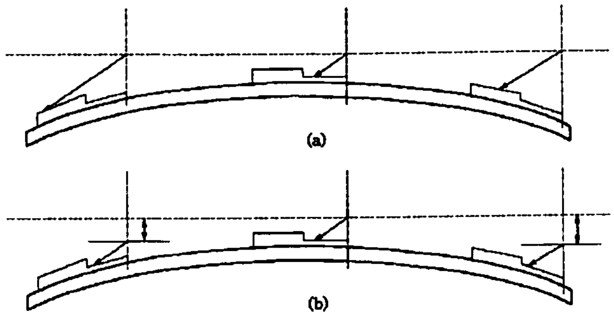
【図6】


スタート
step201
i=0
step202
i=i+1
step203
ウエハー搬入・チャック吸着
step204
プリスキャン
ウエハー内複数点で被露光域内の表面状態（多点のフォーカス計測データをスキャン計測する。
step205
面検出フォーカスデータ補正値算出
上記スキャン計測データから計測誤差・段差量補正値をベストフォーカス位置との差分で算出する。
step206
記憶
上記で算出した計測誤差・段差補正量・計測点の位置情報をメイン制御部（27）に記憶する。
step207
スキャン露光
フォーカス計測データを上記補正値を用いて補正し像面位置への補正量算出・露光領域を像面へ補正。
step208
チャック吸着解除・ウエハ搬出
step209
i≧j
yes
no
step210
step206で記憶したデータを統計処理（j個のデータの平均化処理等）。
A
A
step211
i=i+1
step212
ウエハ搬入・チャック吸着
step213
スキャン露光
step210で求めた計測誤差・段差補正値・計測点の位置情報を用いて、フォーカス計測データを補正し、像面位置への補正量計算・露光領域を像面へ補正。
step214
チャック吸着解除・ウエハ搬出
step215
i=n
yes
no
step216
END

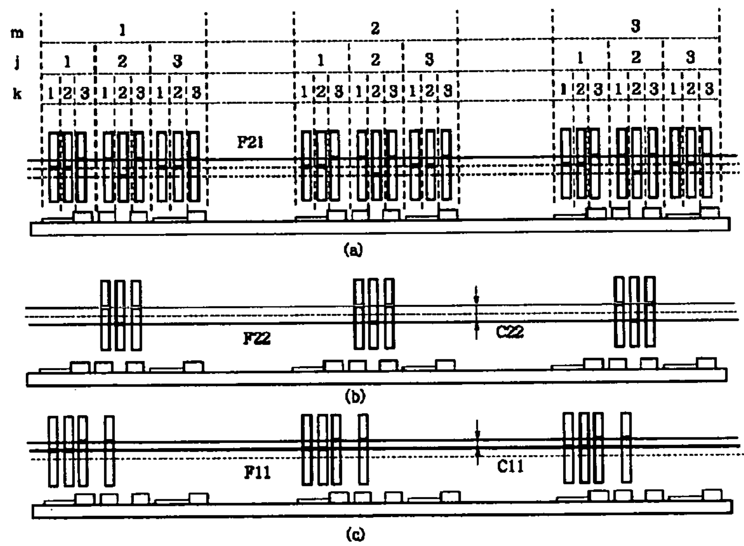
【図7】


スタート
step1
ウエハー搬入・チャック吸着
step2
特定ショットSh（h＝1～g）のアライメントマーク位置データを計測しレチクルパターン基準位置との全露光位置配列ズレ補正値を算出
step3
サンプルショットSi（j＝1～m）へ移動・レベリングステージの位置（Zij, α ij, β ij）をメモリ
step4
サンプルショットSi内の第j計測ポイント（j＝1～n）へ移動し面位置計測を行い検出面を像面近傍へ補正駆動する。
step5
サンプルショットSi内の第j計測ポイント（j＝1～n）での面位置計測データZjk（k＝1～6）を測定しメモリーに記憶する
step6
面位置計測位置でのウエハーステージ位置（Xij、Yij）及びレベリングステージの位置（Zij, α ij, β ij）をメモリに記憶する
step7
j＝nか？
step8
i＝mか？
step9
メモリー内のデータを用いてCjkを算出、メモリーに記憶する。
step10
第N（N＝1～w）ショット位置へウエハーステージ移動開始
step11
第Nショット内の第j計測ポイント（j＝1～n）へ移動
step12
第Nショット第j計測ポイントのZjkを測定
step13
Zik測定時のレベリングステージの位置測定
step14
Zjk－Cjkを算出しこの値から最小自乗平面算出
step15
第Nショット第j計測ポイントを露光スリット位置へ移動すると共に最小自乗平面とレンズ像面のズレ、及びレベリングステージのZjk測定時の位置と現在露光位置との差分を補正してステージを光軸方向と傾き方向に補正駆動する。
step16
j＝nか？
step17
N＝wか？
step18
チャック吸着解除・ウエハー搬出

【図8】



【図9】



CLAIMS

[Claim(s)]
[Claim 1]A surface position detection method which carries out the relatively scan of the object in which a field which has pattern structure was formed to a surface position detection means, and measures a surface position of two or more detecting points in said field by said surface position detection means, comprising:
A stage of detecting an error for every detecting point produced by the difference in pattern structure between said two or more detecting points at the time of said surface position detection means detecting a surface position.
A stage which amends a detection result with said error corresponding to this detecting point for every detecting point when carrying out the relatively scan of said object to said surface position detection means and detecting a surface position of two or more of said detecting points in said field by said surface position detection means.

[Claim 2]Two or more fields which have the same pattern structure as said field are formed in said object, and the relatively scan of said object is carried out to said surface position detection means, A surface position detection method of claim 1 having a stage which amends a detection result with said error corresponding to this detecting point for every detecting point when detecting a surface position of the same part as said two or more detecting points in said two or more fields by said surface position detection means.
[Claim 3]A surface position detection method of claim 2 characterized by comprising the following.
A stage of said error detection stage being in said two or more fields of each, and detecting face shape of said object respectively based on each surface position data for every group of surface position data of the same part.
A stage of detecting said error based on said each face shape.

[Claim 4]While synchronizing reticle and a wafer characterized by comprising the following to a projection optical system and making it scan, when projection exposure of the pattern on said reticle is carried out on said wafer via said projection optical system, A scanning exposure method which detects a surface position of two or more detecting points located in a line with a scanning direction in an exposure region which has the pattern structure on said wafer one by one, and locates said exposure region in an image surface position of said projection optical system.
A stage of detecting an error for producing-by the difference in pattern structure between said two or more detecting points each detecting point of every when detecting a surface position.
A stage which amends a detection result with said error corresponding to this detecting point for every detecting point when detecting a surface position of two or more of said detecting points one by one.

[Claim 5]Two or more exposure regions which have the same pattern structure as said exposure

region to said wafer are formed, A scanning exposure method of claim 4 having a stage which amends a detection result with said error corresponding to this detecting point for every detecting point when detecting a surface position of the same ****** as said two or more detecting points one by one.

[Claim 6]A scanning exposure method of claim 5 characterized by comprising the following.

A stage of said error detection stage being in said two or more exposure regions of each, and detecting face shape of said wafer respectively based on each surface position data for every group of surface position data of the same part.

A stage of detecting said error based on said each face shape.

[Claim 7]How to detect a surface position of the same part in each field of two or more fields which have the same pattern structure formed on said object, respectively, and to detect objective face shape by a surface position detection means which detects an objective surface position according to light flux characterized by comprising the following which carries out oblique incidence to an object

The 1st detection stage that detects a surface position of the same part of said field by said surface position detection means.

A stage of driving said object to a position based on said detection result.

The 2nd detection stage that detects a surface position of the same part of said field again by said surface position detection means after driving said object.

A stage which computes a surface position of each of said field based on a detection result of drive quantity in the case of said drive, and said 2nd detection stage.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]Especially this invention relates to the surface position detection method and scanning exposure method which detect continuously the position of a wafer surface and inclination about the optical axis direction of a projection optical system in the exposure device of a slit scan method (scanning exposure system) about a surface position detection method.
[0002]
[Description of the Prior Art]The size of the latest memory chip shows the expansion tendency gradually from the difference of the expansion trend of the memory space to the resolution of an exposure device, and the reduction trend of cell size, for example, it is reported by the 1st generation of 256M that it is about 14x25 mm.
[0003]In an exposure region with a diameter of 31 mm of the reduced-projection-exposure device (stepper) currently used as an exposure device for the present critical layers in this chip size, only one chip can be exposed per exposure, In order that a throughput may not go up, the exposure device which makes a big exposure area possible is needed. As an exposure device of a big screen, the front projection exposure device is conventionally used widely as an exposure device of big screen liquid crystal display elements, such as a semiconductor device exposure device for rough layers or a monitor by which a high throughput is demanded. This is an exposure device of the slit scan method (scanning exposure system) what is called by a mask wafer relatively scan which carries out the linear scan of the mask by the illumination light of circle slit shape, and carries out one-shot exposure of this on a wafer by a same mind reflection mirror optical system.
[0004]In order that focal ****** of the mask image in these devices may unite with the best image formation face of a projection optical system the exposure surface of a sensitized substrate (the wafer or glass plate in which photoresist etc. were applied) one by one. Correction driving of height measurement and auto-focusing auto leveling is continuously performed during scan exposure.
[0005]The height and surface position detecting mechanism in these devices the catoptric light from a sensitized substrate using what is called an oblique incidence optical system that enters light flux into a wafer surface from the slanting upper part as a position gap on a sensor. It is computed and said that height in case there are a method of using gap sensors, such as the method and air microsensor to detect, and a capacitance sensor, etc. and a measuring point passes through an exposure slit field from two or more height measurement under scan, and the amount of correction driving of inclination are amended.
[0006]
[Problem(s) to be Solved by the Invention]When a projection system is improved so that it may become the resolution which can respond after 256M about the concept of the exposure device of the slit scan method used now, the following problem occurs.
[0007]That is, the allowable depth of the focus in the transfer process of a circuit pattern becomes

increasingly narrow as a reduction projection system is formed into high NA so that it can respond to the minuteness making of a circuit pattern. Since 5 or more um of allowable depth are secured in the exposure device currently used for the present rough process. Although the influence of the measurement error included in the measurement value by which continuation measurement is carried out during scan exposure, or a chip inner step difference can be disregarded, when 256M correspondence is taken into consideration, since the allowable depth is set to 1 or less um, it needs to amend the influence of said measurement error or a chip inner step difference (pattern structure in a chip).
[0008]Two or more chips which have the same pattern structure on a sensitized substrate in the conventional reduced-projection-exposure device are arranged, and since the shape of the surface type is reproduced mostly in an exposure position, if the pilot wafer of precedence performs proof print in advance of lot processing, the above-mentioned offset can be amended. Namely, although the calibration of each measure point of the focus detection systems to a field can be performed, In the exposure device of the above-mentioned slit scan method measured while scanning two or more points in an exposure region, the calibration of this focus sensor for every point of measurement by baking. When it assumes that amendment of 20 points is performed in a chip when asking for example, the work which checks image quality under a microscope also takes 20 times in the case of said reduced-projection-exposure device, and makes productive efficiency get worse greatly.
[0009]When as follows and it amends along the surface even if it constituted the sensor so that a resist surface might be caught certainly, defocusing may occur on the contrary. That is, if the composition of the area within exposure of a memory etc. is roughly divided, the exposure region which it becomes from the portion of a memory cell and the portion of a peripheral circuit and of which critical resolution performance is generally required will be concentrated on the portion of a memory cell. If the chip of 256M is taken for an example, it consists of a loose circumferential circuit part of the rule which builds so that the memory cell field and memory cell field where critical line width transfer is demanded may be divided, and runs beside -. Drawing 4 (a) and (b) expanded this border area. The level difference a cell part and whose circumferential circuit part are about 1 um although flattening is advanced by CMP (chemical mechanical polishing), the recess array forming method, etc. will remain. as shown in drawing 4 (a) now, while scanning this field -- amendment of a Z direction -- a measurement value -- how -- a ****** case, Namely, when making a resist surface always carry out tracking of the exposure image surface of a slit, Supposing a circumferential circuit part has to 5 mm, 2 mm of the width, i.e., the shorter side, of a scanning direction of a slit, defocusing of the memory cell in both the sides of a peripheral circuit with a level difference which is about 1 um in a 2-mm field (hatching portion of drawing 4 (a)) respectively will occur. Since line width management of the peripheral circuit is loose compared with it of a memory cell, focal depth has also expanded it according to it. If this point is taken into consideration, it will think that it is more advantageous in accuracy for making the exposure image surface follow a real level difference (pattern structure) to manage level difference data as a correction amount undesirably, but under the present circumstances, the method of offset management and amendment is not established.
[0010]
[Means for Solving the Problem]This invention is made in view of the conventional problem, The purpose is to provide a surface position detection method which can perform a calibration of a focal measurement system of a multipoint and can detect a position of a wafer surface with high precision. It is in providing a highly precise surface position detection method especially in a slit scan exposure system.
[0011]A gestalt in which this invention has a surface position detection method of this invention carries out the relatively scan of the object in which a field which has pattern structure was formed to a surface position detection means, and is characterized by that a surface position detection method which measures a surface position of two or more detecting points in said field by said

surface position detection means comprises the following.
A stage of detecting an error for every detecting point produced by the difference in pattern structure between said two or more detecting points at the time of said surface position detection means detecting a surface position.
A stage which amends a detection result with said error corresponding to this detecting point for every detecting point when carrying out the relatively scan of said object to said surface position detection means and detecting a surface position of two or more of said detecting points in said field by said surface position detection means.

[0012]A desirable gestalt of said surface position detection method on said object. Two or more fields which have the same pattern structure as said field are formed, and the relatively scan of said object is carried out to said surface position detection means, When detecting a surface position of the same part as said two or more detecting points in said two or more fields by said surface position detection means, it has a stage which amends a detection result with said error corresponding to this detecting point for every detecting point.
[0013]Said error detection stage this invention is characterized by a desirable gestalt comprising the following.
A stage of being in said two or more fields of each, and detecting face shape of said object respectively based on each surface position data for every group of surface position data of the same part.
A stage of detecting said error based on said each face shape.

[0014]A gestalt in which this invention has a scanning exposure method of this invention, While synchronizing reticle and a wafer to a projection optical system and making it scan, when projection exposure of the pattern on said reticle is carried out on said wafer via said projection optical system, A scanning exposure method which detects a surface position of two or more detecting points located in a line with a scanning direction in an exposure region which has the pattern structure on said wafer one by one, and locates said exposure region in an image surface position of said projection optical system is characterized by comprising:
A stage of detecting an error for producing-by the difference in pattern structure between said two or more detecting points each detecting point of every when detecting a surface position.
A stage which amends a detection result with said error corresponding to this detecting point for every detecting point when detecting a surface position of two or more of said detecting points one by one.

[0015]A desirable gestalt of said scanning exposure method to said wafer. When two or more exposure regions which have the same pattern structure as said exposure region are formed and a surface position of the same ****** as said two or more detecting points is detected one by one, it has a stage which amends a detection result with said error corresponding to this detecting point for every detecting point.
[0016]Said error detection stage this invention is characterized by a desirable gestalt comprising the following.
A stage of being in said two or more exposure regions of each, and detecting face shape of said wafer respectively based on each surface position data for every group of surface position data of the same part.
A stage of detecting said error based on said each face shape.

[0017]A gestalt in which this invention has a face shape detecting method of this invention, A method of detecting a surface position of the same part in each field of two or more fields which have the same pattern structure formed on said object, respectively, and detecting objective face

shape by a surface position detection means which detects an objective surface position according to light flux which carries out oblique incidence to an object, is characterized by comprising:
The 1st detection stage that detects a surface position of the same part of said field by said surface position detection means.
A stage of driving said object to a position based on said detection result.
The 2nd detection stage that detects a surface position of the same part of said field again by said surface position detection means after driving said object.
A stage which computes a surface position of each of said field based on a detection result of drive quantity in the case of said drive, and said 2nd detection stage.

[0018]
[Embodiment of the Invention]Drawing 1 is a partial schematic diagram of the projection aligner of the slit scan method which uses the surface position detection method of this invention.
[0019]In drawing 1, 1 is a reduction projection lens, the optic axis is shown in [AX] a figure, and the image surface has a relation vertical to the Z direction in a figure. The reticle 2 is held on the reticle stage 3, reduction projection is carried out for the magnification of a reduction projection lens 1/4 thru/or 1/2, and the pattern of the reticle 2 forms an image in the image surface. 4 is the wafer in which resist was applied to the surface, and many exposure regions (shot) which have the same pattern structure formed by the previous exposure process are arranged. The zipper which 5 is a stage which lays a wafer, and adsorbs and fixes the wafer 4 in the wafer stage 5, Movement to Z shaft orientations and the X-axis which are the directions of an optic axis (AX) of the XY stage in which horizontal migration is possible, and the projection lens 1 respectively in an X axial direction and Y shaft orientations, It is constituted by the pivotable leveling stage and the rotating stage pivotable around the Z-axis around the Y-axis, and 6 stem-correction system for making a reticle pattern image agree in the exposure region on a wafer is constituted.
[0020]10 in drawing 1 to 19 shows each element of the detecting optical system established in order to detect the surface position of the wafer 4, and inclination. 10 is a light source and consists of a lighting unit constituted so that it might irradiate with the light of a white lamp or a high-intensity light emitting diode with two or more different peak wavelength. 11 is a collimating lens and has ejected the light flux from the light source 10 as a parallel pencil in which the intensity distribution of a section is almost uniform. 12 is a prism-shaped slit member, it is pasting the prism of the couple together so that a mutual slant face may face, and it has provided two or more openings (for example, six pinholes) in this lamination side using light-shielding films, such as chromium. 13 is an optical system of both telecentric system, and is carrying out the light guide of the six independent light flux which passed through two or more pinholes of the slit member 12 via the mirror 14 at the six point of measurement on the 4th page of a wafer. In drawing 1, although only 2 light flux is illustrated, each light flux is in a space perpendicular direction also as 3 light flux respectively. The flat surface in which the pinhole is formed to the lens system 13 at this time, and the flat surface including the surface of the wafer 4 are set up satisfy the conditions (Scheinmpflug's condition) of a shine proof.
[0021]In this example, the incidence angle phi to the 4th page of wafer top of each light flux from the Mitsuteru gunner stage (the altitude, i.e., the optic axis, which were built to the wafer surface, and angle to make) is not less than phi= 70 degrees. On the 4th page of the wafer, as shown in drawing 3, two or more exposure regions (shot) which have the same pattern structure are arranged. Incidence and image formation are carrying out six light flux which passed the lens system 13 at each point of measurement in which the pattern space carried out mutually-independent as shown in drawing 2. It is made to enter from the direction of which theta** (for example, 22.5 degrees) rotation was done in the XY plane from X so that the six point of measurement might be mutually observed independently within the 4th page of a wafer (scanning direction 5a).
[0022]As these people have proposed by Japanese Patent Application No. No. 157822 [three to]

by this, spatial arrangement of each element is made suitable and highly precise detection of surface position information is made easy.

[0023]Next, the side which detects the reflected light flux from the wafer 4 explains each composition of 15-19. 16 is receiving six reflected light flux from the 4th page of a wafer via the mirror 15 by the light-receiving optical system of both telecentric system. The stopper diaphragm 17 established in the light-receiving optical system 16 has cut the high order diffracted light (noise light) generated according to the circuit pattern which is established in common to each six point of measurement, and exists on the wafer 4. Re-image formation of the light flux which passed the light-receiving optical system 16 of both telecentric system is carried out so that the optic axis may have become parallel mutually and it may become the spot light of the same size mutually in the detecting face of the photoelectric conversion means group 19 with six individual correcting lenses of the amendment optical system group 18.

[0024]The this side which receives light (from 16 to 18) each point of measurement on the 4th page of a wafer and the detecting face of the photoelectric conversion means group 19, Since it is amending by falling so that it may become conjugate mutually, it is constituted so that the position of the pinhole image in a detecting face does not change with the local inclination to each point of measurement, height change in the optical axis direction AX of each point of measurement may be answered and a pinhole image may change on a detecting face.

[0025]Six one-dimensional CCD line sensors constitute the photoelectric conversion means group 19 here. This is more advantageous than the composition of the two-dimensional sensor conventional at the following point. When the amendment optical system group of 18 is constituted first, the flexibility of arrangement of each optical member or a mechanism electrode holder becomes large by separating a photoelectric conversion means. Although it is necessary to enlarge optical magnification from the mirror 15 to the amendment optical system group 18 for raising the resolution of detection, the direction considered as the composition in which an optical path is divided into and an individual sensor is entered also at this point is able to summarize a member compactly. Furthermore, by a slit scan method, although the focal continuation measurement under exposure becomes indispensable and shortening of measuring time serves as a technical problem absolutely, in the conventional two-dimensional CCD sensor, the cause has also read the data more than needed, but the reading time of 10 times or more of a one-dimensional CCD sensor is needed.

[0026]Next, the exposure system of a slit scan method is explained.

[0027]As shown in drawing 1, while scanning the reticle 2 with constant speed in the direction of arrow 3a (X axial direction) shown in drawing 1 in a field vertical to the optic axis AX of the back projection lens 1 adsorbed and fixed by the reticle stage 3. Correction driving is carried out in the direction (Y shaft orientations: vertical to space) which intersects perpendicularly with the arrow 3a so that a target-coordinates position may always be maintained and scanned. The position information on the direction of X of this reticle stage and the direction of Y is always measured by irradiating two or more laser beams from the reticle interference system (XY) 21 from the exterior to the XY bar mirrors 20 fixed to the reticle stage of drawing 1.

[0028]The exposure illumination-light study system 6 comprises members, such as an unillustrated beam shaping optical system, an optical integrator, a collimator, and a mirror, using the light source which generates pulsed light, such as an excimer laser, and is formed with the material which penetrates or reflects the pulsed light of a far ultraviolet region efficiently. It is for operating a beam shaping optical system orthopedically in the form of a request of the sectional shape (size ****) of an incident beam, and is for an optical integrator's making the lighting distribution characteristic of light flux uniform, and illuminating the reticle 2 with uniform illumination. Corresponding to a chip size, a rectangular illuminated field is set up by the masking blade which is not illustrated in the exposure illumination-light study system 6, and the pattern on the reticle 2 by which partial lighting was carried out in the illuminated field is projected on the wafer 4 in which resist was applied via the projection lens 1.

[0029]The main controlling section 27 shown in drawing 1 the slit image of the reticle 2, adjusting the position (the position of X and Y, and the surrounding rotation theta of the Z-axis) within XY side, and the position (the surrounding rotations alpha and beta of X and Y each ****, and height [on the Z-axis] Z) of a Z direction to the predetermined region of the wafer 4. While synchronizing reticle and a wafer to a projection optical system and making it scan, the whole system is controlled to perform scan exposure which carries out projection exposure of the pattern on the reticle 2 on a wafer via the reduction projection optical system 1. Namely, position ****** in XY side of the pattern on reticle computes control data from the position data of the reticule interferometer 21 and the wafer stage interferometer 24, and the position data of the wafer obtained from an unillustrated alignment microscope, It has realized by controlling the reticle position control system 22 and the wafer position control system 25.
[0030]When scanning the reticle stage 3 in the direction of the drawing 1 arrow 3a, the wafer stage 5 is scanned at the speed amended by the reducing magnification of a projection lens in the direction of the arrow 5a of drawing 1. It is determined that the scanning speed of the reticle stage 3 will become advantageous [a throughput] from the width of the scanning (scan) direction of the masking blade which is not illustrated in the exposure illumination-light study system 6 and the sensitivity of the resist applied to the surface of the wafer 4.
[0031]The alignment of Z shaft orientations of the pattern on reticle, i.e., the alignment to the image surface, is performing control to the leveling stage in a wafer stage via the wafer position control system 25 based on the result of an operation of the surface position detecting system 26 which detects the height data of the wafer 4. That is, inclination to a scanning direction and a perpendicular direction and the height of the optic-axis AX direction are calculated from the height data of three spot light for wafer height measurement arranged near the slit to a scanning direction, and it is amending in quest of the correction amount to the optimal image surface position in an exposure position.
[0032]Next, how to detect the position of the exposure region of the wafer 4 with the surface position detection method of this invention is described.
[0033]In order to detect the position (Z) of the Z direction of the exposure region of the wafer 4, i.e., the position over an image surface position, and the gap which inclines (alpha, beta), while measuring the surface of the wafer 4 correctly, the relation between illuminated field shape and the pattern structure (actual level difference) of an exposure region must also be taken into consideration. When the detection system of an optical system is used to the purpose of measuring the former surface correctly, the factor of the following detection errors can be considered. That is, it is influence of interference with the light reflected in the resist surface of the wafer 4, and the light reflected in the substrates face of the wafer 4. The influence serves as quantity which changes with the construction material of the substrates face which is the pattern structure in a large meaning, and cannot be disregarded in wiring materials of high reflection, such as aluminum. When a capacitance sensor is used as a wafer surface position detecting sensor, having big measurement offset in hard [slight / which is a dielectric] unlike a Si wafer is known for the GaAs wafer used as a high speed element or a substrate of a light emitting diode. Although consideration of the pattern structure (actual level difference) of an exposure region was raised as other examples of a measurement error, it is [direction managing / accuracy / level difference data as a correction amount undesirably, as shown in drawing 4 (b)] advantageous for this to get to have stated also in advance and to make the exposure image surface follow a real level difference.
[0034]The outline of the correcting method is explained using the flow chart of drawing 5. A start command is received by step101, and a wafer is adsorbed to carrying in and a zipper and fixed on a stage by step102. In order to measure the shape of surface type of a chip within the area to be exposed (two or more surface positions) after that, Puri scan measurement (the surface position of two or more places in each exposure region is detected making it actually scan) is performed in two or more sample-shots fields of a slash as shown in drawing 3 by step103. Then, the correction value

(error depending on pattern structure) for amending the surface position detection value under scan exposure in the distance to the optimal exposure image surface position is computed in step104 using the measured surface position detection value (surface position data). If calculation of correction value is completed, the surface position detection value in the detecting point which detects each surface position during scan exposure by step105 will be amended with said correction value corresponding to the pattern structure of the detecting point, and it will expose by doubling an exposure region with the exposure image surface based on the amended surface position detection value.

[0035]It depends for the correction value required in this Puri scan measurement on pattern structure (the actual level difference in an exposure region, the construction material of a substrate). Therefore, with the wafers which passed through the same lot or the same process, since it is thought that pattern structure is the same, it is possible to apply the correction value which asked even for that [first] of at least one sheet to future wafers. The flow chart is shown in drawing 6. By a sequence like the flow chart shown in drawing 6, a large throughput is expectable.

[0036]The instrumentation method of the offset value (correction value) for amending the measurement error factor depending on pattern structure (the actual level difference in an exposure region, the construction material of a substrate) from the surface position detection value under scan exposure hereafter is explained in detail.

[0037]When detecting the surface position of a wafer, and inclination, how to derive the offset value which amends the error depending on the pattern structure (the actual level difference in an exposure region, the construction material of a substrate) which poses a problem from surface position measurement data is explained below using the flow chart of drawing 5.

[0038]In order to compute the above-mentioned offset value first, two or more exposure regions which should carry out scanning measurement as sample shots beforehand are decided. For example, this can acquire efficiently wafer Uenaka [Shin] symmetry and entire information so that it may be hard to be influenced by the profile irregularity of a wafer, it is desirable to choose the position of the exposure region of a slash as shown in drawing 3. This arrangement is because it is assumed that modification occurs in central symmetry from peculiarity called the circle configuration of a wafer when polishing processes, such as CMP, other down stream processing, etc. are taken into consideration. First, by step1, the wafer 4 is carried on the zipper of the wafer stage 5, and it adsorbs and fixes. Focus correction of movement and AA microscope is performed for the alignment mark of a specific shot down to unillustrated AA microscope by step2 after that, and the position of an alignment mark is measured. It changes into the state where the array data of the shot of the total exposure position on a wafer is amended from the alignment data which may be measured at the shot of plurality (g shot) in this measurement, and the alignment of each exposure region can be correctly carried out with reticle during scan exposure. It is expected that the pattern structure at the time of the j-th surface position measurement that the stage coordinate in each exposure position defined since the pattern of each exposure position was processed in the same reticle if it changes into this state will be thoroughly in agreement within the limits of alignment accuracy, It is checked that almost fixed measurement data is actually shown for every measurement. Since the following sample-shots movements and the scan in a shot are performed according to the arrangement information acquired at this step, the chip inner shape in each [in a shot] scanning position between shots will have measured the same part of the same pattern structure within the limits of alignment accuracy. Correction driving of the leveling stage of wafer stage 5 inside is carried out so that the slant components of the whole wafer may be amended before measuring the slant components of the entire wafer surface by focus detection systems in the stage of this measurement and going into step3.

[0039]If the shot arrangement amendment by this step2 is become final and conclusive, it shifts to the sequence of offset measurement in step3. sample-shots Si (i=1-m) determined beforehand first -- inner -- Based on the output signal of the laser interferometer 24 of a wafer system, it moves to

the 1st measuring point (detecting point) position (step3, step4). Then, although the position Zjk (k=1-p) of the surface position measurement data in the wafer surface in the j-th measuring point of the inside of an exposure region, i.e., the optic-axis AX direction of a wafer surface, will be detected by a detecting optical system (10-19), Since it is mostly measured near the image surface of a projection lens at the time of actual exposure, it is necessary to measure near the image surface also in the case of this offset measurement. What is necessary is to fix the height of a wafer (height immobilization of a leveling stage), to perform a step position arrangement in X and the direction of Y for a wafer stage, in order to know the face shape of an entire wafer surface, and just to perform surface position measurement one by one, when the face shape of the wafer is not receiving modification now. However, when processing progresses through down stream processing of plurality [wafer], the shape of an entire wafer surface tends to have the shape of a convex as shown in drawing 8 (a) and (b), or concave. When the detecting optical system of oblique incidence is used in such a wafer that received modification on the whole, If focal measurement is advanced fixing the height of a wafer as shown in drawing 8 (a), the incidence position of the optical beam for detection will be shifted to a transverse direction according to wafer type-like change, i.e., height change. the end -- a possibility of reading a different position from the observation pattern near [which is originally needed] the exposure image surface becomes high. The method of amending the position of a Z stage to an image surface near position in each measuring position, as shown in drawing 8 (b) as a solution of this problem is taken. It returns to drawing 7 and this sequence is explained. The position of a leveling stage is detected by the position detection system of an unillustrated leveling stage in the state where it was first positioned in the XY plane in step5 in the same position as an exposure position, the position (Z0, alpha 0, beta 0) of the leveling stage in the wafer stage 5 -- memory (the 1st point of the first sample shots -- each shot of measurement after that.) After using this data for the correction calculation in each point, it asks for the surface position measurement data in a wafer surface, it moves to an image surface position in a wafer surface using that value, and Z correction driving is performed. By performing Z correction driving of the wafer surface to this image surface position. The problem of a transverse direction shift of said optical beam for detection is lost (drawing 8 (b)), and from the surface position measurement data, i.e., the data of position Z0jk (k=1-p) of the optic-axis AX direction of a wafer surface, in the position (Zj, alpha 0, beta 0) and position of the leveling stage after amendment. It calculates with Zjk(k=1-p) =Z0 jk+Zj-Z0;. Although the example for performing a correction amount (Zj-Z0) by the position detected result of the Z direction of a leveling stage was explained here, Since correction driving of the leveling stage is performed based on the value of measurement value Z0jk, when the drive errors of a leveling stage can be disregarded, it can realize also by adding the value of measurement value Z0jk before correction driving, and the value of Z0jk after correction driving. After inputting the signal corresponding to this position Z0jk (k=1-p) into the focal signal processing part 26 from the primary detecting element 19 which comprised p CCD linear sensors and carrying out the above-mentioned correction calculation, a memory is carried out as a measurement value in the j-th measuring point. The memory also of the position (X, Y) of the wafer stage in this position is simultaneously carried out in step6.

[0040]If it has not judged and ended, it moves to the following measuring point by step4, and it is [whether measurement with the all measuring point in sample shots (j=1-n) ended the measurement same at step7, and] ********** about the same measurement. **** [step8 / it judges whether measurement by all the sample shots (i=1-m) was completed, ends, and] when it ends -- it can kick and moves to step3.

[0041]When judged with measurement with all the all sample measuring points in sample shots having been completed by the judgment of step8, all the measuring points in the measuring position in an exposure position and the offset correction value Cjk in a total sensor position are calculated in step9. In the surface position detection method in JP,6-52707,B which these people proposed previously about this calculation. Although the example of the single point measurement in an

exposure position used by a stepper etc. is explained, the detecting method proposed this time is improved as follows so that it can be used in consideration of application with the exposure device of a scanning method as measurement offset correction in two or more points in high degree of accuracy and an exposure region. By namely, the measurement value Zjk of measuring sensor k in measuring point j in the exposure position obtained by this offset measurement sequence. The face shape function Fnp (x, y) (the number of data points of each face shape function is m points of sample-shots Si (i=1-m)) which shows the face shape of a nxp piece wafer is determined. The degree and expansion of the curved surface of these face shape functions Fnp (x, y) are beforehand defined in the form of the predetermined polynomial, in order to calculate the offset amount of each field, use the measured value Zjk as surface position data, and calculate with a least square method, the coefficient, i.e., the offset correction value, of Fnp.

[0042]concrete -- **(Fjk(x, y)-Zjk (x, y))2dxdy=0 (j=1-n, k=1-p) -- the absolute term Cjk with which it is satisfied of a formula will be searched for.

[0043]The case of the sample shots m= 3, the measuring point j= 3 of a scanning direction, and the measuring sensor k= 3 is explained for the sequence of this correction value derivation using drawing 9 (a). First, for simplification, the flatness of a wafer is one-dimensional and is assumed to be b=c=0 by a plane formula and aX+bY+cZ=d.

[0044]Structure where as for the section structure on a wafer a level difference is measured only for k= 3 to the measuring sensor k= 1 and height with 2 [same] in the measuring point j= 1 as shown in drawing 9 (a) now (for example, under the influence of interference by the portion k= 1 from which memory cell field Nakashita place construction material differs, and 2.) a measurement value shifts to the substrate side -- **** -- j= 3 is repeated and suppose only k= 2 that it has the structure (for example, peripheral circuit area to a memory cell) where measured value with a large level difference is obtained in the measuring point of j= 2. Since the pattern of this exposure region has agreed within the limits of alignment accuracy as shown in a figure when sample shots are measured by m= 1-3, it also reproduces that surface position measured value Zjk.

[0045]Thus, the offset Cjk is calculated by the following computations from the 27 obtained measurement values Zjk. That is, Z21 data of drawing 9 (a) is made to calculate other Cjk(s) as a standard (the offset C21 with the projection lens image surface of this position is actually searched for by exposure etc. for example, with a precedence wafer). The field F21 made from Z21 measurement data of m= 1-3 now is treated as the standard 0, i.e., an absolute term, For example, it is good to ask for the difference about the shape of the wafer of the face shape function F22 searched for at the measurement value of m= 1-3 of Z22 as shown in drawing 9 (b) in quest of the offset C22 of Z22 equivalent to a peripheral circuit area, and Fsaid 21.

[0046]Difference here is a difference quantity of d (section) as used in the field of the formula of a general flat surface, and the value can be computed as C22 of a figure. It is possible to ask as difference of the section of F21 and F11 also about Cof Z11 similarly shifted under influence of interference11. Same calculation is performed also at the time of calculation of other Cjk(s), and the result is memorized in a memory.

[0047]Drawing 7 and drawing 10 explain the process of position amendment of the measurement value amendment and the leveling stage by the focusing position measurement and Cjk in each exposure position succeedingly. As shown, the position (a), i.e., drawing 10, which reached the 1st measuring point of the Nth shot by step11 of drawing 7, and 12 now, while exposing the N-1st shot, the state where the wafer stage 5 is moving to the position which requires a focal measuring beam for the Nth shot 1st measuring point is explained. By step12, the Nth shot, On the Zjk measurement value concrete target in the 1st measuring point, the detecting signal from three CCD linear sensors is processed in the focal signal processing part 26 among the photoelectric conversion means groups 19 to the measuring beam of drawing 10 (a) CR1, CR2, and CR3, and the height data Z11, Z12, and Z13 are calculated. Since the offset error by the measurement error by interference or a level difference is included in this measurement data, original surface position measurement data

ZTjk of a wafer is calculated by asking for difference as follows using the amendment data of Cjk for which it asked by step9.

[0048]ZTjk=Zjk-Cjk -- ZTjk computed here contains only a changed part of the wafer in the exposure area where the measurement offset resulting from a resist surface was amended, and computes a least square flat surface by step14 based on this surface position data.

[0049]Next, correction driving of the wafer stage 5 is carried out to an optical axis direction and an inclination direction, and wafer exposure area is coincided with the reduction projection lens image surface so that the difference of the exposure image surface of the projection lens 1 and said least square flat surface and the difference of the position at the time of Zjk measurement of a leveling stage and a current position may be amended by step15. It is ********** in parallel about measurement and correction driving until it checks whether all the measuring points have been completed by step16 and becomes j=n, after the correction driving of the j-th measuring point is completed as mentioned above.

[0050]That is, the data of j= 1 amends in the state of drawing 10 (b), and measurement and offset correction of a focus are simultaneously performed on the point of j= 2. In the stage scanned in the position of drawing 10 (c) using the amendment data, the data of j= 2 amends and the point of j= 3 performs measurement and offset correction of a focus simultaneously. The data of j= 3 amends in the stage scanned in the position of drawing 10 (d) using the amendment data. It is ********** about each shot scan exposure until it will check whether exposure of a wafer top all exposure shot has been completed by step17 and will become N=w, if measurement and amendment are completed to a j=n point.

[0051]When detecting the surface position of the wafer explained above, and inclination, the offset value of the measurement error which poses a problem, or a chip inner step difference as correction value from measurement data. It is enough as the calibration between sensors, the sequence, i.e., the multipoint focus detecting mechanism, to derive, just to measure only by one in a lot, although it will carry out at each process from which the pattern formed differs, Highly precise leveling amendment and exposure are carried out without being able to realize the original purpose enough by memorizing in the memory the offset Cij searched for by one sheet of a lot head about the same subsequent process, and using it at the time of each focal measurement and amendment, and reducing a throughput.

[0052]It is not what is limited to the above-mentioned example although the sequence which amends the offset for which it depended on the pattern on a wafer in the above-mentioned example was taken for the example. For example, also when carrying out the calibration of the starting point of a multipoint focus, prepare a highly precise flat surface conventionally, or actually by exposure. Although asked, it is possible to search for fixing position offset of a focus sensor simply by carrying out this sequence with the wafer by which pattern processing is not carried out. Also when it is not limited only to a field, either, the height detection sensor of one point performs a scanning focus and you want to always fix the base level in a scan, for example, the surface of a memory cell, to an image surface position, it is possible by performing the same offset correction sequence.

[0053]It is not what is restricted to one point although one point with the focal severest depth, such as a memory cell, is exposed a priori in an exposure region in the above-mentioned example and it asked for the best focus, In order to ask for change by the environment of a device factor, i.e., a lens. When it is better to have measured at least 1 point and to change a focal corrected position individually in an exposure region (i.e., when surface height differs selectively with a logic device etc.), the data of the above-mentioned surface position data offset Cij may be amended from the designed value. When the field which should change offset from the two-dimensional map specifically defined by Cij in consideration of the width of an illuminated field slit is large, Cij is amended by a part for the level difference.

[0054]

[Effect of the Invention]The detection error which originates in the IC pattern of the exposure

region on a wafer according to this invention as explained above, and surface stepping structure, It measures, when a focus value carries out a PURISU can on the conditions measured with high precision most in advance of exposure, And the detection error of the focal measurement value measured during scan exposure can be amended in real time by carrying out offset management in the exposure region on the basis of the height of the portion as which focus accuracy is required most.

[0055]Therefore, without being influenced by the level difference also in the wafer where the process progressed with the slit scan exposure device etc., and the level difference has been made on the surface, the original distortion component of a wafer can be amended and an exposure region can be certainly positioned in the depth of focus. for this reason, better pattern transfer is performed and there is an outstanding effect that it is stabilized and the circuit where a degree of location is higher than that after 256M can be created.

[Translation done.]

TECHNICAL FIELD

[Field of the Invention]Especially this invention relates to the surface position detection method and scanning exposure method which detect continuously the position of a wafer surface and inclination about the optical axis direction of a projection optical system in the exposure device of a slit scan method (scanning exposure system) about a surface position detection method.

[Translation done.]

PRIOR ART

[Description of the Prior Art]The size of the latest memory chip shows the expansion tendency gradually from the difference of the expansion trend of the memory space to the resolution of an exposure device, and the reduction trend of cell size, for example, it is reported by the 1st generation of 256M that it is about 14x25 mm.
[0003]In an exposure region with a diameter of 31 mm of the reduced-projection-exposure device (stepper) currently used as an exposure device for the present critical layers in this chip size, only one chip can be exposed per exposure, In order that a throughput may not go up, the exposure device which makes a big exposure area possible is needed. As an exposure device of a big screen, the front projection exposure device is conventionally used widely as an exposure device of big screen liquid crystal display elements, such as a semiconductor device exposure device for rough layers or a monitor by which a high throughput is demanded. This is an exposure device of the slit scan method (scanning exposure system) what is called by a mask wafer relatively scan which carries out the linear scan of the mask by the illumination light of circle slit shape, and carries out one-shot exposure of this on a wafer by a same mind reflection mirror optical system.
[0004]In order that focal ****** of the mask image in these devices may unite with the best image formation face of a projection optical system the exposure surface of a sensitized substrate (the wafer or glass plate in which photoresist etc. were applied) one by one. Correction driving of height measurement and auto-focusing auto leveling is continuously performed during scan exposure.
[0005]The height and surface position detecting mechanism in these devices the catoptric light from a sensitized substrate using what is called an oblique incidence optical system that enters light flux into a wafer surface from the slanting upper part as a position gap on a sensor. It is computed and said that height in case there are a method of using gap sensors, such as the method and air microsensor to detect, and a capacitance sensor, etc. and a measuring point passes through an exposure slit field from two or more height measurement under scan, and the amount of correction driving of inclination are amended.

[Translation done.]

EFFECT OF THE INVENTION

[Effect of the Invention]As explained above, in this invention, a focus value carries out the PURISU can of the detection error resulting from the IC pattern of the exposure region on a wafer, and the surface stepping structure on the conditions measured with high precision most in advance of exposure.
Therefore, the detection error of the focal measurement value measured during scan exposure can be amended in real time by carrying out offset management on the basis of the height of the portion as which it measures and focus accuracy is most required in the exposure region.

[0055]Therefore, without being influenced by the level difference also in the wafer where the process progressed with the slit scan exposure device etc., and the level difference has been made on the surface, the original distortion component of a wafer can be amended and an exposure region can be certainly positioned in the depth of focus. for this reason, better pattern transfer is performed and there is an outstanding effect that it is stabilized and the circuit where a degree of location is higher than that after 256M can be created.

[Translation done.]

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention]When a projection system is improved so that it may become the resolution which can respond after 256M about the concept of the exposure device of the slit scan method used now, the following problem occurs.
[0007]That is, the allowable depth of the focus in the transfer process of a circuit pattern becomes increasingly narrow as a reduction projection system is formed into high NA so that it can respond to the minuteness making of a circuit pattern. Since 5 or more um of allowable depth are secured in the exposure device currently used for the present rough process. Although the influence of the measurement error included in the measurement value by which continuation measurement is carried out during scan exposure, or a chip inner step difference can be disregarded, when 256M correspondence is taken into consideration, since the allowable depth is set to 1 or less um, it needs to amend the influence of said measurement error or a chip inner step difference (pattern structure in a chip).
[0008]Two or more chips which have the same pattern structure on a sensitized substrate in the conventional reduced-projection-exposure device are arranged, and since the shape of the surface type is reproduced mostly in an exposure position, if the pilot wafer of precedence performs proof print in advance of lot processing, the above-mentioned offset can be amended. Namely, although the calibration of each measure point of the focus detection systems to a field can be performed, In the exposure device of the above-mentioned slit scan method measured while scanning two or more points in an exposure region, the calibration of this focus sensor for every point of measurement by baking. When it assumes that amendment of 20 points is performed in a chip when asking for example, the work which checks image quality under a microscope also takes 20 times in the case of said reduced-projection-exposure device, and makes productive efficiency get worse greatly.
[0009]When as follows and it amends along the surface even if it constituted the sensor so that a resist surface might be caught certainly, defocusing may occur on the contrary. That is, if the composition of the area within exposure of a memory etc. is roughly divided, the exposure region which it becomes from the portion of a memory cell and the portion of a peripheral circuit and of which critical resolution performance is generally required will be concentrated on the portion of a memory cell. If the chip of 256M is taken for an example, it consists of a loose circumferential circuit part of the rule which builds so that the memory cell field and memory cell field where critical line width transfer is demanded may be divided, and runs beside -. Drawing 4 (a) and (b) expanded this border area. The level difference a cell part and whose circumferential circuit part are about 1 um although flattening is advanced by CMP (chemical mechanical polishing), the recess array forming method, etc. will remain. as shown in drawing 4 (a) now, while scanning this field -- amendment of a Z direction -- a measurement value -- how -- a ****** case, Namely, when making a resist surface always carry out tracking of the exposure image surface of a slit, Supposing a circumferential circuit part has to 5 mm, 2 mm of the width, i.e., the shorter side, of a scanning direction of a slit, defocusing of the memory cell in both the sides of a peripheral circuit with a level

difference which is about 1 um in a 2-mm field (hatching portion of drawing 4 (a)) respectively will occur. Since line width management of the peripheral circuit is loose compared with it of a memory cell, focal depth has also expanded it according to it. If this point is taken into consideration, it will think that it is more advantageous in accuracy for making the exposure image surface follow a real level difference (pattern structure) to manage level difference data as a correction amount undesirably, but under the present circumstances, the method of offset management and amendment is not established.

[Translation done.]

MEANS

[Means for Solving the Problem]This invention is made in view of the conventional problem, The purpose is to provide a surface position detection method which can perform a calibration of a focal measurement system of a multipoint and can detect a position of a wafer surface with high precision. It is in providing a highly precise surface position detection method especially in a slit scan exposure system.
[0011]A gestalt in which this invention has a surface position detection method of this invention carries out the relatively scan of the object in which a field which has pattern structure was formed to a surface position detection means, and is characterized by that a surface position detection method which measures a surface position of two or more detecting points in said field by said surface position detection means comprises the following.
A stage of detecting an error for every detecting point produced by the difference in pattern structure between said two or more detecting points at the time of said surface position detection means detecting a surface position.
A stage which amends a detection result with said error corresponding to this detecting point for every detecting point when carrying out the relatively scan of said object to said surface position detection means and detecting a surface position of two or more of said detecting points in said field by said surface position detection means.

[0012]A desirable gestalt of said surface position detection method on said object. Two or more fields which have the same pattern structure as said field are formed, and the relatively scan of said object is carried out to said surface position detection means, When detecting a surface position of the same part as said two or more detecting points in said two or more fields by said surface position detection means, it has a stage which amends a detection result with said error corresponding to this detecting point for every detecting point.
[0013]Said error detection stage this invention is characterized by a desirable gestalt comprising the following.
A stage of being in said two or more fields of each, and detecting face shape of said object respectively based on each surface position data for every group of surface position data of the same part.
A stage of detecting said error based on said each face shape.

[0014]A gestalt in which this invention has a scanning exposure method of this invention, While synchronizing reticle and a wafer to a projection optical system and making it scan, when projection exposure of the pattern on said reticle is carried out on said wafer via said projection optical system, A scanning exposure method which detects a surface position of two or more detecting points located in a line with a scanning direction in an exposure region which has the pattern structure on said wafer one by one, and locates said exposure region in an image surface position of

said projection optical system is characterized by comprising:
A stage of detecting an error for producing-by the difference in pattern structure between said two or more detecting points each detecting point of every when detecting a surface position.
A stage which amends a detection result with said error corresponding to this detecting point for every detecting point when detecting a surface position of two or more of said detecting points one by one.

[0015]A desirable gestalt of said scanning exposure method to said wafer. When two or more exposure regions which have the same pattern structure as said exposure region are formed and a surface position of the same ****** as said two or more detecting points is detected one by one, it has a stage which amends a detection result with said error corresponding to this detecting point for every detecting point.
[0016]Said error detection stage this invention is characterized by a desirable gestalt comprising the following.
A stage of being in said two or more exposure regions of each, and detecting face shape of said wafer respectively based on each surface position data for every group of surface position data of the same part.
A stage of detecting said error based on said each face shape.

[0017]A gestalt in which this invention has a face shape detecting method of this invention, A method of detecting a surface position of the same part in each field of two or more fields which have the same pattern structure formed on said object, respectively, and detecting objective face shape by a surface position detection means which detects an objective surface position according to light flux which carries out oblique incidence to an object, is characterized by comprising:
The 1st detection stage that detects a surface position of the same part of said field by said surface position detection means.
A stage of driving said object to a position based on said detection result.
The 2nd detection stage that detects a surface position of the same part of said field again by said surface position detection means after driving said object.
A stage which computes a surface position of each of said field based on a detection result of drive quantity in the case of said drive, and said 2nd detection stage.

[0018]
[Embodiment of the Invention]Drawing 1 is a partial schematic diagram of the projection aligner of the slit scan method which uses the surface position detection method of this invention.
[0019]In drawing 1, 1 is a reduction projection lens, the optic axis is shown in [AX] a figure, and the image surface has a relation vertical to the Z direction in a figure. The reticle 2 is held on the reticle stage 3, reduction projection is carried out for the magnification of a reduction projection lens 1/4 thru/or 1/2, and the pattern of the reticle 2 forms an image in the image surface. 4 is the wafer in which resist was applied to the surface, and many exposure regions (shot) which have the same pattern structure formed by the previous exposure process are arranged. The zipper which 5 is a stage which lays a wafer, and adsorbs and fixes the wafer 4 in the wafer stage 5, Movement to Z shaft orientations and the X-axis which are the directions of an optic axis (AX) of the XY stage in which horizontal migration is possible, and the projection lens 1 respectively in an X axial direction and Y shaft orientations, It is constituted by the pivotable leveling stage and the rotating stage pivotable around the Z-axis around the Y-axis, and 6 stem-correction system for making a reticle pattern image agree in the exposure region on a wafer is constituted.
[0020]10 in drawing 1 to 19 shows each element of the detecting optical system established in order to detect the surface position of the wafer 4, and inclination. 10 is a light source and consists of a lighting unit constituted so that it might irradiate with the light of a white lamp or a high-intensity

light emitting diode with two or more different peak wavelength. 11 is a collimating lens and has ejected the light flux from the light source 10 as a parallel pencil in which the intensity distribution of a section is almost uniform. 12 is a prism-shaped slit member, it is pasting the prism of the couple together so that a mutual slant face may face, and it has provided two or more openings (for example, six pinholes) in this lamination side using light-shielding films, such as chromium. 13 is an optical system of both telecentric system, and is carrying out the light guide of the six independent light flux which passed through two or more pinholes of the slit member 12 via the mirror 14 at the six point of measurement on the 4th page of a wafer. In drawing 1, although only 2 light flux is illustrated, each light flux is in a space perpendicular direction also as 3 light flux respectively. The flat surface in which the pinhole is formed to the lens system 13 at this time, and the flat surface including the surface of the wafer 4 are set up satisfy the conditions (Scheinmpflug's condition) of a shine proof.

[0021]In this example, the incidence angle phi to the 4th page of wafer top of each light flux from the Mitsuteru gunner stage (the altitude, i.e., the optic axis, which were built to the wafer surface, and angle to make) is not less than phi= 70 degrees. On the 4th page of the wafer, as shown in drawing 3, two or more exposure regions (shot) which have the same pattern structure are arranged. Incidence and image formation are carrying out six light flux which passed the lens system 13 at each point of measurement in which the pattern space carried out mutually-independent as shown in drawing 2. It is made to enter from the direction of which theta** (for example, 22.5 degrees) rotation was done in the XY plane from X so that the six point of measurement might be mutually observed independently within the 4th page of a wafer (scanning direction 5a).

[0022]As these people have proposed by Japanese Patent Application No. No. 157822 [three to] by this, spatial arrangement of each element is made suitable and highly precise detection of surface position information is made easy.

[0023]Next, the side which detects the reflected light flux from the wafer 4 explains each composition of 15-19. 16 is receiving six reflected light flux from the 4th page of a wafer via the mirror 15 by the light-receiving optical system of both telecentric system. The stopper diaphragm 17 established in the light-receiving optical system 16 has cut the high order diffracted light (noise light) generated according to the circuit pattern which is established in common to each six point of measurement, and exists on the wafer 4. Re-image formation of the light flux which passed the light-receiving optical system 16 of both telecentric system is carried out so that the optic axis may have become parallel mutually and it may become the spot light of the same size mutually in the detecting face of the photoelectric conversion means group 19 with six individual correcting lenses of the amendment optical system group 18.

[0024]The this side which receives light (from 16 to 18) each point of measurement on the 4th page of a wafer and the detecting face of the photoelectric conversion means group 19, Since it is amending by falling so that it may become conjugate mutually, it is constituted so that the position of the pinhole image in a detecting face does not change with the local inclination to each point of measurement, height change in the optical axis direction AX of each point of measurement may be answered and a pinhole image may change on a detecting face.

[0025]Six one-dimensional CCD line sensors constitute the photoelectric conversion means group 19 here. This is more advantageous than the composition of the two-dimensional sensor conventional at the following point. When the amendment optical system group of 18 is constituted first, the flexibility of arrangement of each optical member or a mechanism electrode holder becomes large by separating a photoelectric conversion means. Although it is necessary to enlarge optical magnification from the mirror 15 to the amendment optical system group 18 for raising the resolution of detection, the direction considered as the composition in which an optical path is divided into and an individual sensor is entered also at this point is able to summarize a member compactly. Furthermore, by a slit scan method, although the focal continuation measurement under exposure becomes indispensable and shortening of measuring time serves as a technical problem

absolutely, in the conventional two-dimensional CCD sensor, the cause has also read the data more than needed, but the reading time of 10 times or more of a one-dimensional CCD sensor is needed.

[0026]Next, the exposure system of a slit scan method is explained.

[0027]As shown in drawing 1, while scanning the reticle 2 with constant speed in the direction of arrow 3a (X axial direction) shown in drawing 1 in a field vertical to the optic axis AX of the back projection lens 1 adsorbed and fixed by the reticle stage 3. Correction driving is carried out in the direction (Y shaft orientations: vertical to space) which intersects perpendicularly with the arrow 3a so that a target-coordinates position may always be maintained and scanned. The position information on the direction of X of this reticle stage and the direction of Y is always measured by irradiating two or more laser beams from the reticle interference system (XY) 21 from the exterior to the XY bar mirrors 20 fixed to the reticle stage of drawing 1.

[0028]The exposure illumination-light study system 6 comprises members, such as an unillustrated beam shaping optical system, an optical integrator, a collimator, and a mirror, using the light source which generates pulsed light, such as an excimer laser, and is formed with the material which penetrates or reflects the pulsed light of a far ultraviolet region efficiently. It is for operating a beam shaping optical system orthopedically in the form of a request of the sectional shape (size ****) of an incident beam, and is for an optical integrator's making the lighting distribution characteristic of light flux uniform, and illuminating the reticle 2 with uniform illumination. Corresponding to a chip size, a rectangular illuminated field is set up by the masking blade which is not illustrated in the exposure illumination-light study system 6, and the pattern on the reticle 2 by which partial lighting was carried out in the illuminated field is projected on the wafer 4 in which resist was applied via the projection lens 1.

[0029]The main controlling section 27 shown in drawing 1 the slit image of the reticle 2, adjusting the position (the position of X and Y, and the surrounding rotation theta of the Z-axis) within XY side, and the position (the surrounding rotations alpha and beta of X and Y each ****, and height [on the Z-axis] Z) of a Z direction to the predetermined region of the wafer 4. While synchronizing reticle and a wafer to a projection optical system and making it scan, the whole system is controlled to perform scan exposure which carries out projection exposure of the pattern on the reticle 2 on a wafer via the reduction projection optical system 1. Namely, position ****** in XY side of the pattern on reticle computes control data from the position data of the reticule interferometer 21 and the wafer stage interferometer 24, and the position data of the wafer obtained from an unillustrated alignment microscope, It has realized by controlling the reticle position control system 22 and the wafer position control system 25.

[0030]When scanning the reticle stage 3 in the direction of the drawing 1 arrow 3a, the wafer stage 5 is scanned at the speed amended by the reducing magnification of a projection lens in the direction of the arrow 5a of drawing 1. It is determined that the scanning speed of the reticle stage 3 will become advantageous [a throughput] from the width of the scanning (scan) direction of the masking blade which is not illustrated in the exposure illumination-light study system 6 and the sensitivity of the resist applied to the surface of the wafer 4.

[0031]The alignment of Z shaft orientations of the pattern on reticle, i.e., the alignment to the image surface, is performing control to the leveling stage in a wafer stage via the wafer position control system 25 based on the result of an operation of the surface position detecting system 26 which detects the height data of the wafer 4. That is, inclination to a scanning direction and a perpendicular direction and the height of the optic-axis AX direction are calculated from the height data of three spot light for wafer height measurement arranged near the slit to a scanning direction, and it is amending in quest of the correction amount to the optimal image surface position in an exposure position.

[0032]Next, how to detect the position of the exposure region of the wafer 4 with the surface position detection method of this invention is described.

[0033]In order to detect the position (Z) of the Z direction of the exposure region of the wafer 4,

i.e., the position over an image surface position, and the gap which inclines (alpha, beta), while measuring the surface of the wafer 4 correctly, the relation between illuminated field shape and the pattern structure (actual level difference) of an exposure region must also be taken into consideration. When the detection system of an optical system is used to the purpose of measuring the former surface correctly, the factor of the following detection errors can be considered. That is, it is influence of interference with the light reflected in the resist surface of the wafer 4, and the light reflected in the substrates face of the wafer 4. The influence serves as quantity which changes with the construction material of the substrates face which is the pattern structure in a large meaning, and cannot be disregarded in wiring materials of high reflection, such as aluminum. When a capacitance sensor is used as a wafer surface position detecting sensor, having big measurement offset in hard [slight / which is a dielectric] unlike a Si wafer is known for the GaAs wafer used as a high speed element or a substrate of a light emitting diode. Although consideration of the pattern structure (actual level difference) of an exposure region was raised as other examples of a measurement error, it is [direction managing / accuracy / level difference data as a correction amount undesirably, as shown in drawing 4 (b)] advantageous for this to get to have stated also in advance and to make the exposure image surface follow a real level difference.

[0034]The outline of the correcting method is explained using the flow chart of drawing 5. A start command is received by step101, and a wafer is adsorbed to carrying in and a zipper and fixed on a stage by step102. In order to measure the shape of surface type of a chip within the area to be exposed (two or more surface positions) after that, Puri scan measurement (the surface position of two or more places in each exposure region is detected making it actually scan) is performed in two or more sample-shots fields of a slash as shown in drawing 3 by step103. Then, the correction value (error depending on pattern structure) for amending the surface position detection value under scan exposure in the distance to the optimal exposure image surface position is computed in step104 using the measured surface position detection value (surface position data). If calculation of correction value is completed, the surface position detection value in the detecting point which detects each surface position during scan exposure by step105 will be amended with said correction value corresponding to the pattern structure of the detecting point, and it will expose by doubling an exposure region with the exposure image surface based on the amended surface position detection value.

[0035]It depends for the correction value required in this Puri scan measurement on pattern structure (the actual level difference in an exposure region, the construction material of a substrate). Therefore, with the wafers which passed through the same lot or the same process, since it is thought that pattern structure is the same, it is possible to apply the correction value which asked even for that [first] of at least one sheet to future wafers. The flow chart is shown in drawing 6. By a sequence like the flow chart shown in drawing 6, a large throughput is expectable.

[0036]The instrumentation method of the offset value (correction value) for amending the measurement error factor depending on pattern structure (the actual level difference in an exposure region, the construction material of a substrate) from the surface position detection value under scan exposure hereafter is explained in detail.

[0037]When detecting the surface position of a wafer, and inclination, how to derive the offset value which amends the error depending on the pattern structure (the actual level difference in an exposure region, the construction material of a substrate) which poses a problem from surface position measurement data is explained below using the flow chart of drawing 5.

[0038]In order to compute the above-mentioned offset value first, two or more exposure regions which should carry out scanning measurement as sample shots beforehand are decided. For example, this can acquire efficiently wafer Uenaka [Shin] symmetry and entire information so that it may be hard to be influenced by the profile irregularity of a wafer, it is desirable to choose the position of the exposure region of a slash as shown in drawing 3. This arrangement is because it is assumed that modification occurs in central symmetry from peculiarity called the circle

configuration of a wafer when polishing processes, such as CMP, other down stream processing, etc. are taken into consideration. First, by step1, the wafer 4 is carried on the zipper of the wafer stage 5, and it adsorbs and fixes. Focus correction of movement and AA microscope is performed for the alignment mark of a specific shot down to unillustrated AA microscope by step2 after that, and the position of an alignment mark is measured. It changes into the state where the array data of the shot of the total exposure position on a wafer is amended from the alignment data which may be measured at the shot of plurality (g shot) in this measurement, and the alignment of each exposure region can be correctly carried out with reticle during scan exposure. It is expected that the pattern structure at the time of the j-th surface position measurement that the stage coordinate in each exposure position defined since the pattern of each exposure position was processed in the same reticle if it changes into this state will be thoroughly in agreement within the limits of alignment accuracy, It is checked that almost fixed measurement data is actually shown for every measurement. Since the following sample-shots movements and the scan in a shot are performed according to the arrangement information acquired at this step, the chip inner shape in each [in a shot] scanning position between shots will have measured the same part of the same pattern structure within the limits of alignment accuracy. Correction driving of the leveling stage of wafer stage 5 inside is carried out so that the slant components of the whole wafer may be amended before measuring the slant components of the entire wafer surface by focus detection systems in the stage of this measurement and going into step3.

[0039]If the shot arrangement amendment by this step2 is become final and conclusive, it shifts to the sequence of offset measurement in step3. sample-shots Si (i=1-m) determined beforehand first -- inner -- Based on the output signal of the laser interferometer 24 of a wafer system, it moves to the 1st measuring point (detecting point) position (step3, step4). Then, although the position Zjk (k=1-p) of the surface position measurement data in the wafer surface in the j-th measuring point of the inside of an exposure region, i.e., the optic-axis AX direction of a wafer surface, will be detected by a detecting optical system (10-19), Since it is mostly measured near the image surface of a projection lens at the time of actual exposure, it is necessary to measure near the image surface also in the case of this offset measurement. What is necessary is to fix the height of a wafer (height immobilization of a leveling stage), to perform a step position arrangement in X and the direction of Y for a wafer stage, in order to know the face shape of an entire wafer surface, and just to perform surface position measurement one by one, when the face shape of the wafer is not receiving modification now. However, when processing progresses through down stream processing of plurality [wafer], the shape of an entire wafer surface tends to have the shape of a convex as shown in drawing 8 (a) and (b), or concave. When the detecting optical system of oblique incidence is used in such a wafer that received modification on the whole, If focal measurement is advanced fixing the height of a wafer as shown in drawing 8 (a), the incidence position of the optical beam for detection will be shifted to a transverse direction according to wafer type-like change, i.e., height change. the end -- a possibility of reading a different position from the observation pattern near [which is originally needed] the exposure image surface becomes high. The method of amending the position of a Z stage to an image surface near position in each measuring position, as shown in drawing 8 (b) as a solution of this problem is taken. It returns to drawing 7 and this sequence is explained. The position of a leveling stage is detected by the position detection system of an unillustrated leveling stage in the state where it was first positioned in the XY plane in step5 in the same position as an exposure position, the position (Z0, alpha 0, beta 0) of the leveling stage in the wafer stage 5 -- memory (the 1st point of the first sample shots -- each shot of measurement after that.) After using this data for the correction calculation in each point, it asks for the surface position measurement data in a wafer surface, it moves to an image surface position in a wafer surface using that value, and Z correction driving is performed. By performing Z correction driving of the wafer surface to this image surface position. The problem of a transverse direction shift of said optical beam for detection is lost (drawing 8 (b)), and from the surface position measurement data, i.e., the

data of position Z0jk (k=1-p) of the optic-axis AX direction of a wafer surface, in the position (Zj, alpha 0, beta 0) and position of the leveling stage after amendment. It calculates with Zjk(k=1-p) =Z0 jk+Zj-Z0;. Although the example for performing a correction amount (Zj-Z0) by the position detected result of the Z direction of a leveling stage was explained here, Since correction driving of the leveling stage is performed based on the value of measurement value Z0jk, when the drive errors of a leveling stage can be disregarded, it can realize also by adding the value of measurement value Z0jk before correction driving, and the value of Z0jk after correction driving. After inputting the signal corresponding to this position Z0jk (k=1-p) into the focal signal processing part 26 from the primary detecting element 19 which comprised p CCD linear sensors and carrying out the above-mentioned correction calculation, a memory is carried out as a measurement value in the j-th measuring point. The memory also of the position (X, Y) of the wafer stage in this position is simultaneously carried out in step6.
[0040]If it has not judged and ended, it moves to the following measuring point by step4, and it is [whether measurement with the all measuring point in sample shots (j=1-n) ended the measurement same at step7, and] ********** about the same measurement. **** [step8 / it judges whether measurement by all the sample shots (i=1-m) was completed, ends, and] when it ends -- it can kick and moves to step3.
[0041]When judged with measurement with all the all sample measuring points in sample shots having been completed by the judgment of step8, all the measuring points in the measuring position in an exposure position and the offset correction value Cjk in a total sensor position are calculated in step9. In the surface position detection method in JP,6-52707,B which these people proposed previously about this calculation. Although the example of the single point measurement in an exposure position used by a stepper etc. is explained, the detecting method proposed this time is improved as follows so that it can be used in consideration of application with the exposure device of a scanning method as measurement offset correction in two or more points in high degree of accuracy and an exposure region. By namely, the measurement value Zjk of measuring sensor k in measuring point j in the exposure position obtained by this offset measurement sequence. The face shape function Fnp (x, y) (the number of data points of each face shape function is m points of sample-shots Si (i=1-m)) which shows the face shape of a nxp piece wafer is determined. The degree and expansion of the curved surface of these face shape functions Fnp (x, y) are beforehand defined in the form of the predetermined polynomial, in order to calculate the offset amount of each field, use the measured value Zjk as surface position data, and calculate with a least square method, the coefficient, i.e., the offset correction value, of Fnp.
[0042]concrete -- **(Fjk(x, y)-Zjk (x, y))2dxdy=0 (j=1-n, k=1-p) -- the absolute term Cjk with which it is satisfied of a formula will be searched for.
[0043]The case of the sample shots m= 3, the measuring point j= 3 of a scanning direction, and the measuring sensor k= 3 is explained for the sequence of this correction value derivation using drawing 9 (a). First, for simplification, the flatness of a wafer is one-dimensional and is assumed to be b=c=0 by a plane formula and aX+bY+cZ=d.
[0044]Structure where as for the section structure on a wafer a level difference is measured only for k= 3 to the measuring sensor k= 1 and height with 2 [same] in the measuring point j= 1 as shown in drawing 9 (a) now (for example, under the influence of interference by the portion k= 1 from which memory cell field Nakashita place construction material differs, and 2.) a measurement value shifts to the substrate side -- **** -- j= 3 is repeated and suppose only k= 2 that it has the structure (for example, peripheral circuit area to a memory cell) where measured value with a large level difference is obtained in the measuring point of j= 2. Since the pattern of this exposure region has agreed within the limits of alignment accuracy as shown in a figure when sample shots are measured by m= 1-3, it also reproduces that surface position measured value Zjk.
[0045]Thus, the offset Cjk is calculated by the following computations from the 27 obtained measurement values Zjk. That is, Z21 data of drawing 9 (a) is made to calculate other Cjk(s) as a

standard (the offset C21 with the projection lens image surface of this position is actually searched for by exposure etc. for example, with a precedence wafer). The field F21 made from Z21 measurement data of m= 1-3 now is treated as the standard 0, i.e., an absolute term, For example, it is good to ask for the difference about the shape of the wafer of the face shape function F22 searched for at the measurement value of m= 1-3 of Z22 as shown in drawing 9 (b) in quest of the offset C22 of Z22 equivalent to a peripheral circuit area, and Fsaid 21.

[0046]Difference here is a difference quantity of d (section) as used in the field of the formula of a general flat surface, and the value can be computed as C22 of a figure. It is possible to ask as difference of the section of F21 and F11 also about Cof Z11 similarly shifted under influence of interference11. Same calculation is performed also at the time of calculation of other Cjk(s), and the result is memorized in a memory.

[0047]Drawing 7 and drawing 10 explain the process of position amendment of the measurement value amendment and the leveling stage by the focusing position measurement and Cjk in each exposure position succeedingly. As shown, the position (a), i.e., drawing 10, which reached the 1st measuring point of the Nth shot by step11 of drawing 7, and 12 now, while exposing the N-1st shot, the state where the wafer stage 5 is moving to the position which requires a focal measuring beam for the Nth shot 1st measuring point is explained. By step12, the Nth shot, On the Zjk measurement value concrete target in the 1st measuring point, the detecting signal from three CCD linear sensors is processed in the focal signal processing part 26 among the photoelectric conversion means groups 19 to the measuring beam of drawing 10 (a) CR1, CR2, and CR3, and the height data Z11, Z12, and Z13 are calculated. Since the offset error by the measurement error by interference or a level difference is included in this measurement data, original surface position measurement data ZTjk of a wafer is calculated by asking for difference as follows using the amendment data of Cjk for which it asked by step9.

[0048]ZTjk=Zjk-Cjk -- ZTjk computed here contains only a changed part of the wafer in the exposure area where the measurement offset resulting from a resist surface was amended, and computes a least square flat surface by step14 based on this surface position data.

[0049]Next, correction driving of the wafer stage 5 is carried out to an optical axis direction and an inclination direction, and wafer exposure area is coincided with the reduction projection lens image surface so that the difference of the exposure image surface of the projection lens 1 and said least square flat surface and the difference of the position at the time of Zjk measurement of a leveling stage and a current position may be amended by step15. It is ********** in parallel about measurement and correction driving until it checks whether all the measuring points have been completed by step16 and becomes j=n, after the correction driving of the j-th measuring point is completed as mentioned above.

[0050]That is, the data of j= 1 amends in the state of drawing 10 (b), and measurement and offset correction of a focus are simultaneously performed on the point of j= 2. In the stage scanned in the position of drawing 10 (c) using the amendment data, the data of j= 2 amends and the point of j= 3 performs measurement and offset correction of a focus simultaneously. The data of j= 3 amends in the stage scanned in the position of drawing 10 (d) using the amendment data. It is ********** about each shot scan exposure until it will check whether exposure of a wafer top all exposure shot has been completed by step17 and will become N=w, if measurement and amendment are completed to a j=n point.

[0051]When detecting the surface position of the wafer explained above, and inclination, the offset value of the measurement error which poses a problem, or a chip inner step difference as correction value from measurement data. It is enough as the calibration between sensors, the sequence, i.e., the multipoint focus detecting mechanism, to derive, just to measure only by one in a lot, although it will carry out at each process from which the pattern formed differs, Highly precise leveling amendment and exposure are carried out without being able to realize the original purpose enough by memorizing in the memory the offset Cij searched for by one sheet of a lot head about the same

subsequent process, and using it at the time of each focal measurement and amendment, and reducing a throughput.
[0052]It is not what is limited to the above-mentioned example although the sequence which amends the offset for which it depended on the pattern on a wafer in the above-mentioned example was taken for the example. For example, also when carrying out the calibration of the starting point of a multipoint focus, prepare a highly precise flat surface conventionally, or actually by exposure. Although asked, it is possible to search for fixing position offset of a focus sensor simply by carrying out this sequence with the wafer by which pattern processing is not carried out. Also when it is not limited only to a field, either, the height detection sensor of one point performs a scanning focus and you want to always fix the base level in a scan, for example, the surface of a memory cell, to an image surface position, it is possible by performing the same offset correction sequence.
[0053]It is not what is restricted to one point although one point with the focal severest depth, such as a memory cell, is exposed a priori in an exposure region in the above-mentioned example and it asked for the best focus, In order to ask for change by the environment of a device factor, i.e., a lens. When it is better to have measured at least 1 point and to change a focal corrected position individually in an exposure region (i.e., when surface height differs selectively with a logic device etc.), the data of the above-mentioned surface position data offset Cij may be amended from the designed value. When the field which should change offset from the two-dimensional map specifically defined by Cij in consideration of the width of an illuminated field slit is large, Cij is amended by a part for the level difference.

[Translation done.]

DESCRIPTION OF DRAWINGS

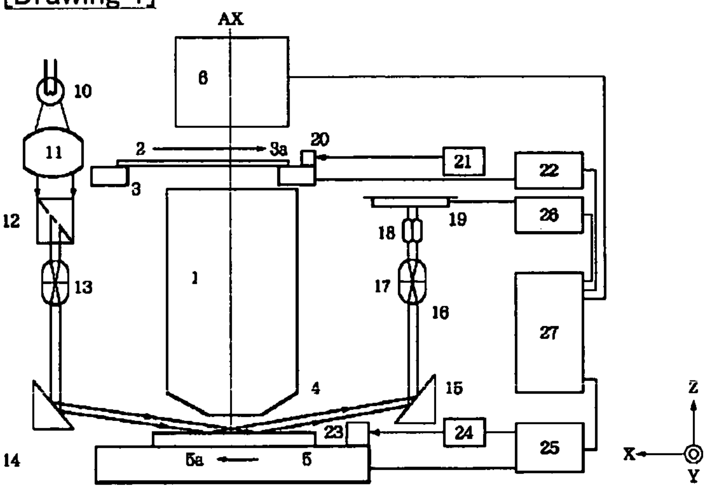
[Brief Description of the Drawings]
[Drawing 1]The partial schematic diagram of the projection aligner of the slit scan method using the surface position detection method of this invention.
[Drawing 2]The explanatory view showing the exposure slit in surface position detection and the physical relationship of each point of measurement by a detecting optical system.
[Drawing 3]The top view showing the example of selection of the sample shots which perform a PURISU can by the array state and this invention of an exposure region on a wafer.
[Drawing 4]The explanatory view explaining the relation of the image surface position of the slit exposure by which focus control was carried out to the exposure region which shows IC surface topography under exposure region scan.
[Drawing 5]The flow chart figure showing the example of an outline of measurement of the offset using the surface position detection method of this invention, and the sequence of the surface position correction driving at the time of exposure at each shot.
[Drawing 6]The flow chart figure showing the example of a sequence of the lot commencement of work using surface position detection of this invention.
[Drawing 7]The flow chart figure showing one example of the sequence of the surface position correction driving at the time of exposure at the measurement and each shot of offset using the surface position detection method of this invention.
[Drawing 8]The explanatory view explaining the necessity of performing correction driving for computing focal offset to the high degree of accuracy of this invention.
[Drawing 9]The explanatory view which illustrates the method of offset calculation of this invention concretely.
[Drawing 10]The explanatory view explaining the slit at the time of the slit scan exposure using the surface position detection method of this invention, and the physical relationship of a surface position detection sensor.
[Description of Notations]
1 Reduction projection lens
2 Reticle
3 Reticle stage
4 Wafer
5 Wafer stage
6 Exposure illumination-light study system
10 Light source
11 Collimating lens
12 A prism-shaped slit member
14 Bending mirror
15 Bending mirror

19 Photoelectric conversion means group
,21 Reticle stage interferometer
22 Reticle position control system
24 Wafer stage interferometer
25 Wafer position control system
26 Surface position detecting system
27 Main controlling section

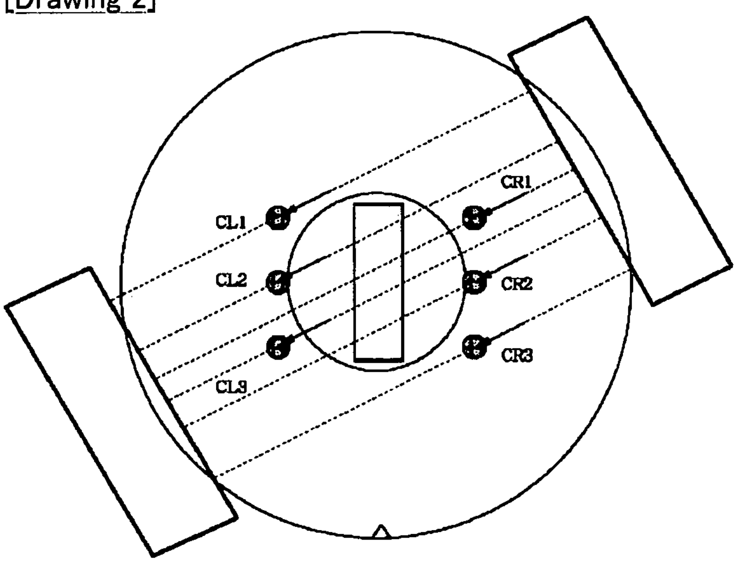
[Translation done.]

DRAWINGS

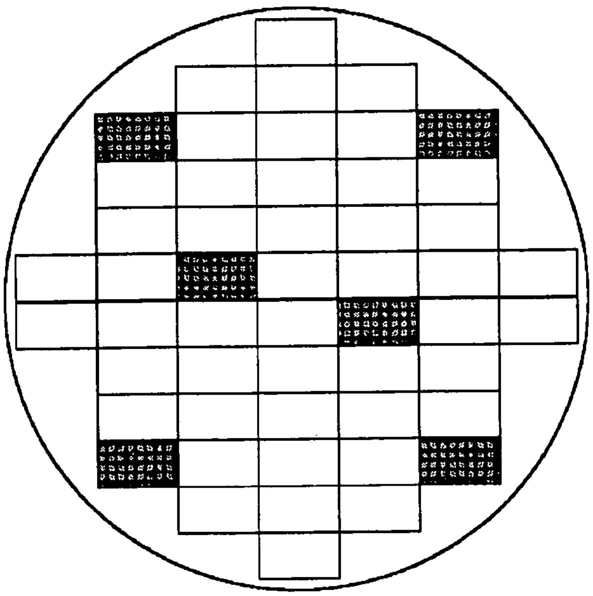
[Drawing 1]



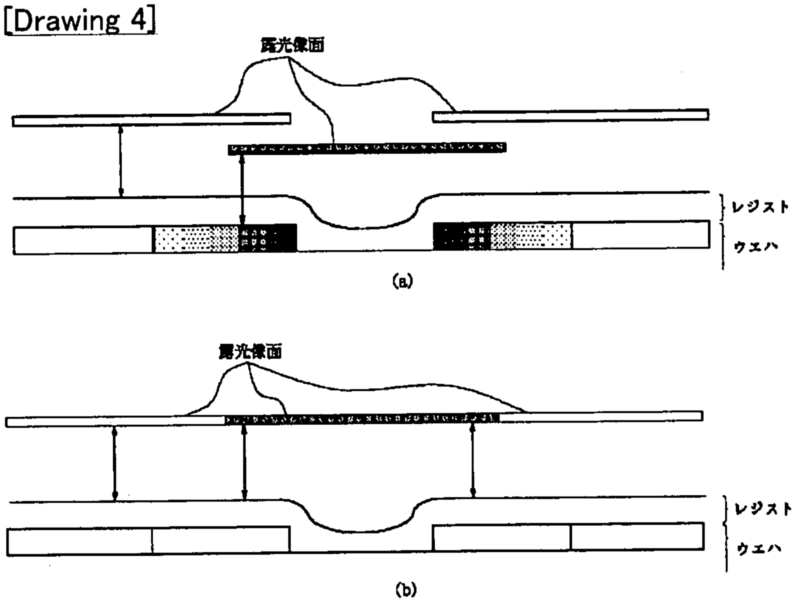
[Drawing 2]



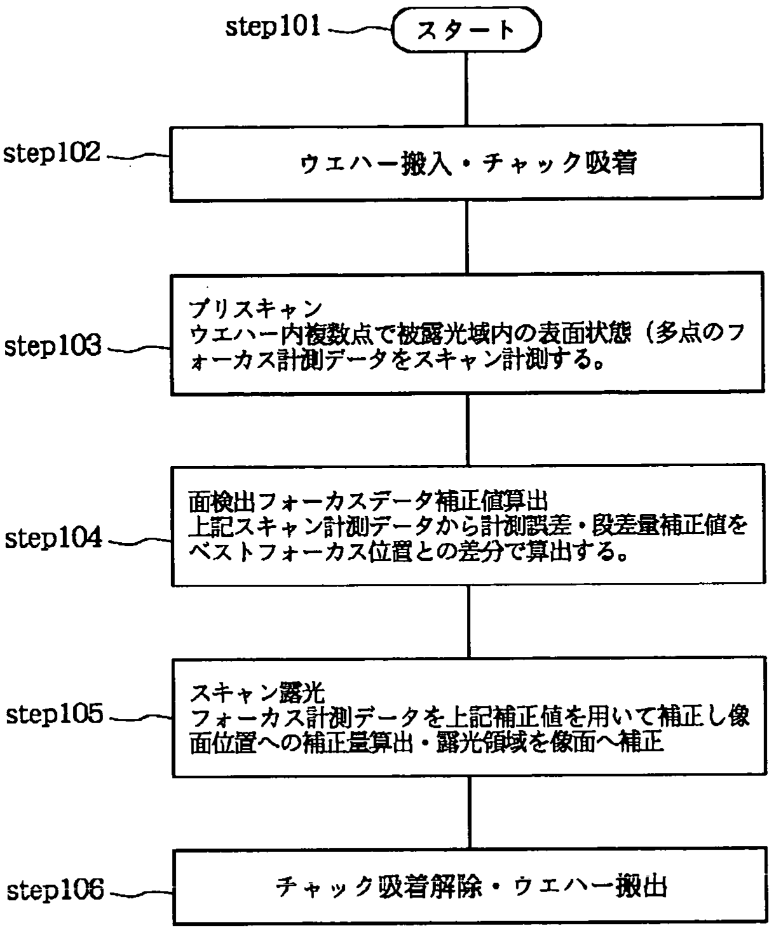
[Drawing 3]



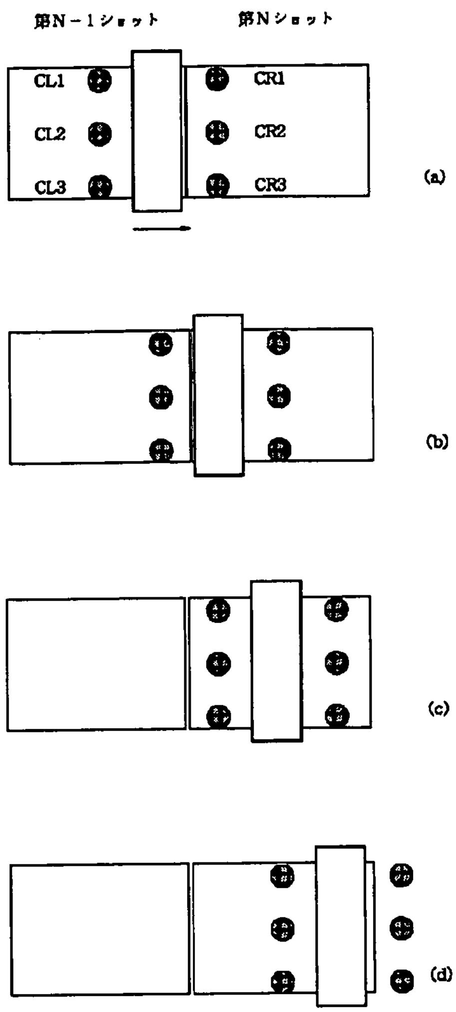
[Drawing 4]



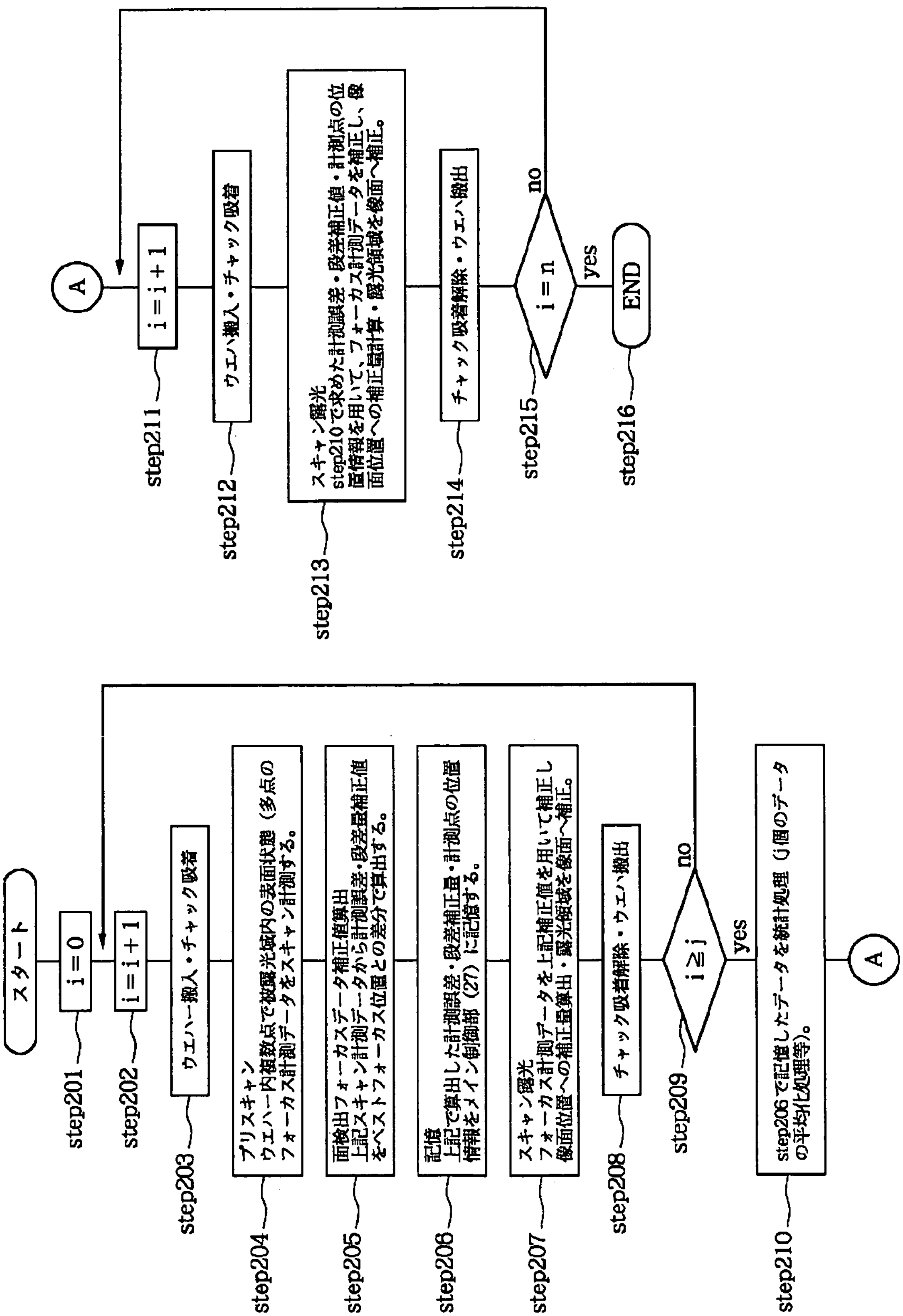
[Drawing 5]


step101
スタート
step102
ウエハー搬入・チャック吸着
step103
プリスキャン
ウエハー内複数点で被露光域内の表面状態（多点のフォーカス計測データをスキャン計測する。
step104
面検出フォーカスデータ補正値算出
上記スキャン計測データから計測誤差・段差量補正値をベストフォーカス位置との差分で算出する。
step105
スキャン露光
フォーカス計測データを上記補正値を用いて補正し像面位置への補正量算出・露光領域を像面へ補正
step106
チャック吸着解除・ウエハー搬出

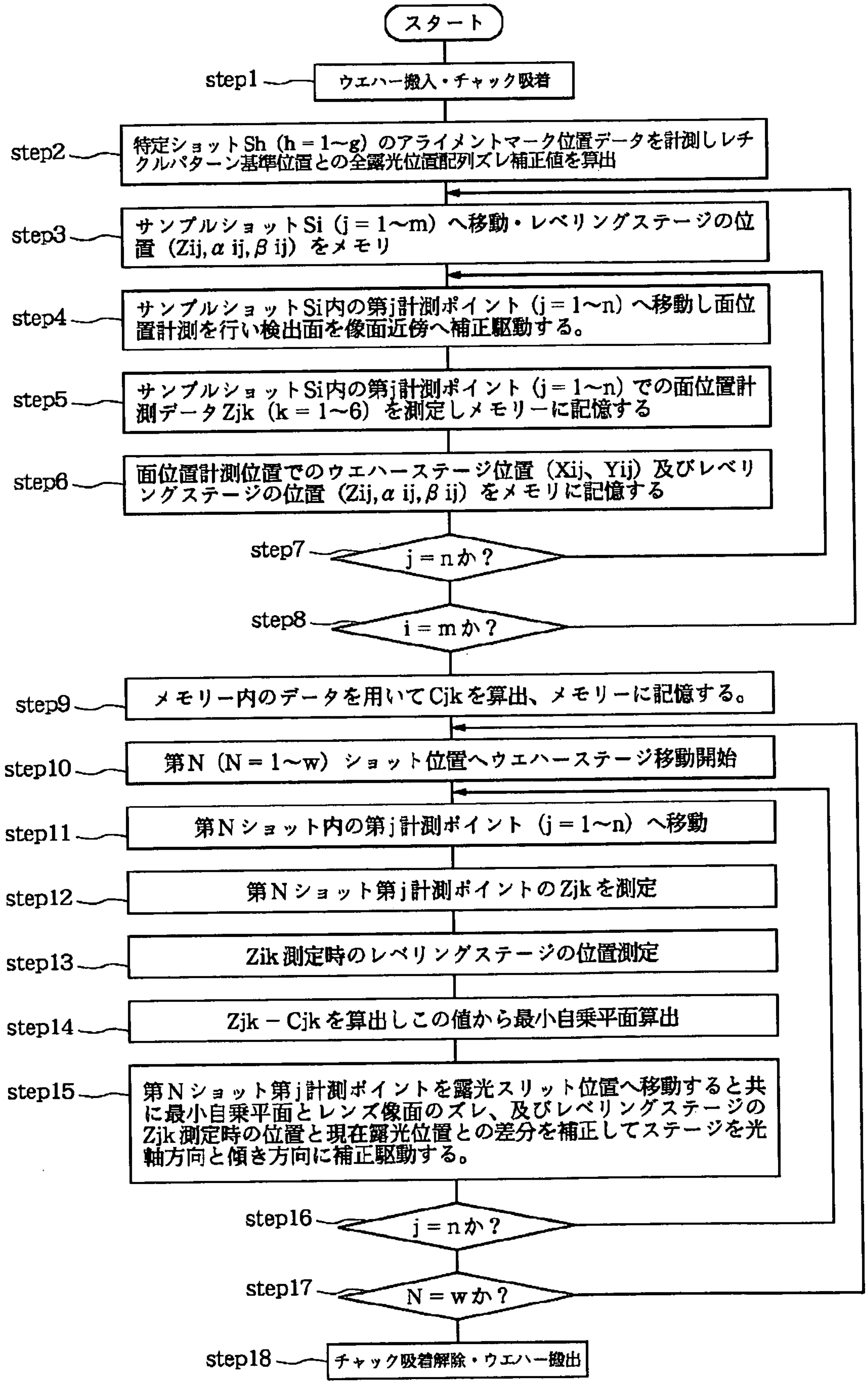
[Drawing 10]



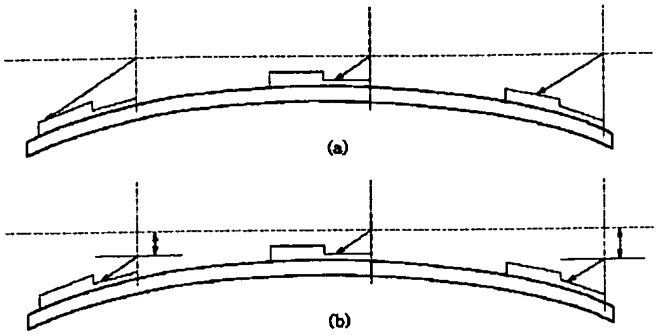
[Drawing 6]


スタート
i＝0
step201
i＝i＋1
step202
ウエハー搬入・チャック吸着
step203
プリスキャン
ウエハー内複数点で被露光域内の表面状態（多点のフォーカス計測データをスキャン計測する。
step204
面検出フォーカスデータ補正値算出
上記スキャン計測データから計測誤差・段差量補正値をベストフォーカス位置との差分で算出する。
step205
記憶
上記で算出した計測誤差・段差補正量・計測点の位置情報をメイン制御部（27）に記憶する。
step206
スキャン露光
フォーカス計測データを上記補正値を用いて補正し像面位置への補正量算出・露光領域を像面へ補正。
step207
チャック吸着解除・ウエハ搬出
step208
i≧j
step209
yes
no
step206で記憶したデータを統計処理（j個のデータの平均化処理等）。
step210
A
A
i＝i＋1
step211
ウエハ搬入・チャック吸着
step212
スキャン露光
step210で求めた計測誤差・段差補正値・計測点の位置情報を用いて、フォーカス計測データを補正し、像面位置への補正量計算・露光領域を像面へ補正。
step213
チャック吸着解除・ウエハ搬出
step214
i＝n
step215
yes
no
END
step216

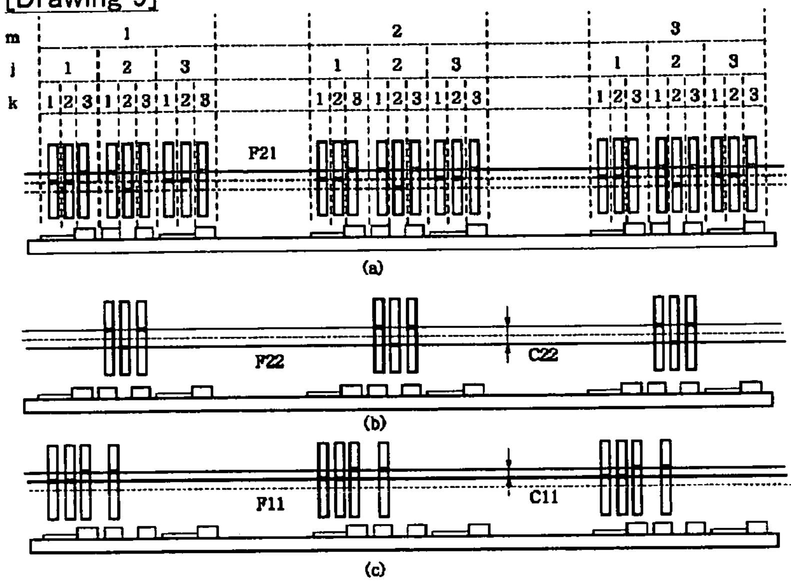
[Drawing 7]


スタート
step1
ウエハー搬入・チャック吸着
step2
特定ショットSh（h＝1〜g）のアライメントマーク位置データを計測しレチクルパターン基準位置との全露光位置配列ズレ補正値を算出
step3
サンプルショットSi（j＝1〜m）へ移動・レベリングステージの位置（Zij,α ij,β ij）をメモリ
step4
サンプルショットSi内の第j計測ポイント（j＝1〜n）へ移動し面位置計測を行い検出面を像面近傍へ補正駆動する。
step5
サンプルショットSi内の第j計測ポイント（j＝1〜n）での面位置計測データZjk（k＝1〜6）を測定しメモリーに記憶する
step6
面位置計測位置でのウエハーステージ位置（Xij、Yij）及びレベリングステージの位置（Zij,α ij,β ij）をメモリに記憶する
step7
j＝nか？
step8
i＝mか？
step9
メモリー内のデータを用いてCjkを算出、メモリーに記憶する。
step10
第N（N＝1〜w）ショット位置へウエハーステージ移動開始
step11
第Nショット内の第j計測ポイント（j＝1〜n）へ移動
step12
第Nショット第j計測ポイントのZjkを測定
step13
Zik測定時のレベリングステージの位置測定
step14
Zjk－Cjkを算出しこの値から最小自乗平面算出
step15
第Nショット第j計測ポイントを露光スリット位置へ移動すると共に最小自乗平面とレンズ像面のズレ、及びレベリングステージのZjk測定時の位置と現在露光位置との差分を補正してステージを光軸方向と傾き方向に補正駆動する。
step16
j＝nか？
step17
N＝wか？
step18
チャック吸着解除・ウエハー搬出

[Drawing 8]



[Drawing 9]



[Translation done.]